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Design, Implementation and Assessment of a Soil Education Camp for Children at the Suan Phung Nature Education Park Ratchaburi Province, Thailand

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Abstract

The Office of HRH Princess Maha Chakri Sirindhorn has been working to educate children about environmental conservation in Suan Phung Nature Education Park, Ratchaburi, Thailand. In this project we designed, implemented, and evaluated a new environmental camp that addresses environmental issues specific to Suan Phung. The camp we designed focused on soil conservation. The curriculum was piloted and evaluation of the camp led to recommendations for curriculum modifications and environmental education.

Executive Summary

Between 1990 and 2005, Thailand lost approximately 9% of its forest cover, a remarkably high figure compared to the estimated global forest loss of 3% (FAO, 2005). The country has recognized the problem of environmental destruction, and has greatly increased the area of its protected areas and national parks in the past 15 years (Roth, 2004). An important part of the effort to slow the alarming rate of environmental degradation in Thailand has been educating people how to better manage the environment. The office of Her Royal Highness Princess Maha Chakri Sirindhorn has been a leader in this effort, creating programs that teach people in rural areas of Thailand how to earn a living without destroying the environment that sustains them.

Suan Phung Nature Education Park is a protected area in the Ratchaburi Province of Thailand that was founded through the initiative of the Princess. It was created to research and protect the unique biodiversity of the area, and to teach the local people how they can improve their lives without unnecessarily damaging the environment. As part of that mission, the Park conducts a number of educational camps for children that teach them about the environment and encourage them to do their part to protect it.

These programs are an important part of the work in Suan Phung. The children are the future leaders of this community, and are often more open to change. Research into effective environmental education has shown that education of children is a viable means to change the habits of an entire community (IGES, 2002). The Park was pleased with its existing series of four three-day educational camps for children, but wanted to add more of these programs.

Our goal for this project was to create a new camp for Suan Phung Nature Education Park to teach local children about environmental issues. Throughout this process we wanted to ensure that the program we designed fulfilled the needs of our sponsor and the community. To accomplish this goal, we first investigated what the Park, the people of the region, and the ecosystem in Suan Phung needed in an environmental education program. This led us to choose soil conservation as a topic for the camp. Second, we researched soil science and what local children were learning about it in order to create a list of educational objectives for the camp program. Third, we collected information about the Park's resources and effective teaching methods in order to develop a curriculum that would accomplish the educational objectives.

This allowed us to implement the camp program, and to complete our fourth and final objective: evaluating the program. We measured how well the camp had achieved its objectives, including how engaging it was for the students. This process allowed us to make final recommendations to improve the camp program.

In order to choose a topic for the camp program that fit the Park's needs, we investigated the social issues and resources of the Park area. This involved visiting the Park and observing the stress people have placed on the environment. We learned from the Princess' projects office about the history of the area, and how mining, development, and poor farming techniques have hurt the region. We learned about what the Park was already teaching children, and what topics they were interested in teaching.

Through this process, we identified soil conservation as an important topic that was not being taught extensively by either the Park or the local schools. This subject would link with the topics the Park was teaching in its other programs, as well as the area's history of soil degradation from mining and unsustainable agriculture. Also, solutions to the environmental problems we observed in the park require long term planning. For this reason, we decided to make a major focus of the new camp teaching children to think about the long-term effects of their actions. We learned that it is difficult for the people of Suan Phung to develop this kind of outlook because many of them survive by practicing subsistence farming.

Once we selected soil conservation as the subject of the program, we began deciding what topics should be taught during the three-day camp. We researched literature on soil science to determine what elements of it were important to teach, and decided that erosion, soil quality, and soil-conserving agriculture would be core topics in the camp. We then interviewed students and surveyed 12 local teachers to find out what the local students were already learning. While 12 teachers seems like a small number to draw reliable conclusions from, the Suan Phung area only has 6 small schools, so the sample we collected represents a significant portion of the area's teaching staff. We found that very little soil science was being taught to children in Suan Phung, and that students were not absorbing the information that was provided. This information allowed us to refine the general topics for the camp into a list of educational objectives we wanted the program to achieve.

The next step of our process was to design a curriculum for the camp that would accomplish those objectives. We interviewed local children from 4 of the area's 6 schools about

what they enjoyed in school and the camp programs they had attended. We also asked them to tell us what they learned at the previous camps. We found that the students were interested in lectures, but generally enjoyed hands-on experiments and research. We also found that the activity they remembered the most about from previous camp programs was when they got to act as "Water Rangers" and surveyed water in the area to determine its quality. Some discussions with these students' teachers confirmed these findings. Because of this, we decided to present some background material early on in the camp in lecture format, but we made sure that all the important topics were the focus of at least one hands-on activity. We also designed an activity that allowed the students to be "Soil Scientists" for a day.

From the curriculum we designed, we implemented the three-day camp program. In the final stages of preparing the camp, we tried to involve as many local educators as possible. Our background research into environmental education had showed that community involvement in an environmental education program significantly increased the chances that the program would be successful and continue for a long time. Our sponsor also requested that we incorporate local teachers as much as possible, because it was their goal to transfer the load of teaching these camps to the local teachers. We were also interested in gaining the expertise and experience of professional educators. We contacted teachers in the nearby schools, explained the program to them, and asked them if they would be interested in helping. The teachers were very enthusiastic; involvement with our program gave them a chance to see new ideas for presenting soil science in an interesting way. We hope that they will be able to adapt what they see to their own classrooms, and extend soil science education beyond the camp program.

All of our work culminated in a pilot camp conducted from February 17th-19th, 2006. Graduate students and faculty from the Chulalongkorn Faculty of Environmental and Hazardous Waste Management worked as camp instructors along with Royal Projects Office staff and Park staff. We also received a great deal of assistance in providing educational entertainment from the Rabbit in the Moon organization.

This pilot of the camp served to identify camp elements that needed improvement and led to the development of general recommendations for teaching environmental education in Suan Phung. Prior to conducting the camp, we developed three methods for evaluating its success: a pre- and post-test, observation, and teacher surveys. When the camp was actually implemented, however, the evaluation methods did not go exactly as we had planned. The primary

modification to these methods was the elimination of teacher surveys in favor of daily debriefing sessions during the camp. These debriefing sessions, along with our personal observations, allowed for the immediate evaluation of the camp. Based on what we found each day, we were able to make adjustments to the camp activities on later days. This was particularly true for the first day of the camp, during which we identified that activities needed to be simplified because students struggled with written communication. We also found that fun activities needed to be better interspersed with the educational activities to keep students engaged. Another major finding of that first day was that the students were shy and consequently had trouble working in groups. The changes we made to the next day's activities were reflective of these findings.

The process of attempting to carry out the evaluation led to discoveries about the students in Suan Phung and how to design evaluation materials for future programs. The pre-test consisted of open response questions. Administering the test demonstrated that the students have a particular difficulty with written communication. Throughout the camp students had trouble completing work that required writing. The standardized observation sheets showed us that conducting objective observations and instructing at the same time is very difficult. These findings led to recommendations for the development of more appropriate evaluation tools that can provide better feedback in the future.

The information we found, although not gathered in the way we had intended, allowed us to make recommendations to improve this camp when it is carried out in the future. We were able to suggest three recommendations for improvements to the soil camp program which were beyond the scope of this project, and nine areas for future work and research into environmental education in Suan Phung.

Recommendations for improvements to the Soil Conservation Camp

- Assessment methods
- Teacher involvement
- Continuous improvement of curriculum

Recommendations for future research and work in environmental education in Suan Phung Nature Education Park.

- Training program for local teachers and staff;
- Partnership between a college and the Park ;
- Teaching packets for local teachers ;
- More camps on other environmental issues;
- One day camp programs;
- Standard program for all local students (have all the students in a certain grade go through camp series instead of a mix of grades);
- Process to design a conservation group for local people;
- Adult environmental education program;
- Community-teacher network (based at the Park to organize environmental education and spread ideas for teaching methods).

Our research enabled us to design, implement, evaluate, and improve upon a soil conservation camp for primary school students. We have used what we learned from running the trial camp to make changes to the camp materials so that Suan Phung Nature Education Park can use them to run this camp again. Our recommendations are intended to guide the creation of effective camps and educational materials in the future. It is our hope that what we have produced will be used to educate the community on ways to protect and preserve the environment for a long time in the future, and over time will help the community of Suan Phung earn their living without damaging the environment.

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1.0 Introduction

Approximately 45% of the people in developing countries around the world are unable to afford the basic necessities of life (Wright, 2005). Economic growth in those countries is needed to raise those impoverished people above the poverty line. If, however, this growth is not managed properly, it can unbalance delicate ecosystems (Hirsh, 1996). When short-term material gains are not balanced with the impact they have on the environment, destructive practices become commonplace. Balancing the need for both economic growth and environmental conservation has become an international imperative, and the term "Sustainable Development" has been coined to describe the optimal balance between these forces (Wright, 2005)

Thailand falls into the "moderately developed" class of nations, as defined by the World Bank (Wright, 2005). While many of its people enjoy a lifestyle similar to the high-income, industrialized countries of the world, a significant portion of its population is still living in poverty. This is especially true in the more remote rural areas of Thailand. In these regions, many people still practice subsistence agriculture, and do not have the opportunity to continue their education after primary school. Additionally, many people are recent arrivals to the area, whose relocation was motivated by economic or political forces. Because many rural communities do not have access to the most recent techniques in sustainable agriculture, in many cases they have mismanaged the land they work and damaged the environment.

The office of Princess Maha Chakri Sirindhorn has developed a number of projects to help guide the rural people of Thailand along the path of sustainable development. Suan Phung Nature Education Park is one of these projects. The mission of the Park is to protect and research the unique biodiversity of the Suan Phung area, and to teach the local people how to improve their lives in an environmentally sustainable manner. As part of this mission, the Park has implemented a series of nature education camps to teach local children about the threats to the environment around them, and how they can help preserve the area's natural resources.

The children's education programs are an important element of the work of Suan Phung because children are the future leaders of the community. Young children can also be less set in their ways and more open to new ideas than adults. Educating them now about environmental issues can change their outlook for the rest of their life, and lead to a future community based on a more sustainable lifestyle (IGES, 2002). When educating children about the environment,

research has shown that it is important that the curriculum extends beyond the classroom (The World Conservation Union [IUCN], 2002; IGES, 2002). For this reason, the camp setting is an important part of these students' environmental education. Four camps had already been run in Suan Phung, each on a different subject, but there were still many environmental topics that needed to be taught. For this reason, the Royal Projects Office of the Princess wanted to extend and improve their existing program of environmental camps.

Our project goal was to design, implement, and evaluate a new environmental education camp for the Suan Phung Nature Education Park. Design of the program required investigation into the major threats to the environment specific to the Park, what teaching methods were successful in previous environmental camps, and what the local communities and the Royal Projects Office considered important. We designed a curriculum in collaboration with local teachers and university students, and oversaw the first implementation of the camp with 40 local students from the 6 surrounding schools. To further refine the program, we conducted an evaluation and recommended improvements. Based on our experience developing and observing the camp, we provide recommendations for future enrichment of environmental education in Suan Phung.

2.0 Background

The Suan Phung Nature Education Park was founded by the initiative of HRH Princess Maha Chakri Sirindhorn with four main objectives:

1. to conserve and improve the area and to create a place for natural conservation education for local people and general public;
2. to explore, research and collect all data on physical, biological and social resources within the area;
3. to apply research studies for local community benefit;
4. to promote the participation of local people in natural conservation (Petchkleang, 2006).

In the pursuit of these goals, the Royal Projects Office of HRH Princess Maha Chakri Sirindhorn, which oversees the Suan Phung Nature Education Park, is in the process of designing and implementing a series of environmental education camps. The following section draws connections between the environmental and social aspects of the area and people unique to Suan Phung. The second section discusses important aspects of successful environmental education. The final section outlines steps for the evaluation of an environmental education program.

2.1 Suan Phung

The Suan Phung Nature Education Park officially opened in February 2004 through the initiative of Her Royal Highness (HRH) Princess Maha Chakri Sirindhorn. The Park is located along the border between Thailand and Myanmar in the Suan Phung district of the Ratchaburi Province, as shown in Figure 2.1-1. Her Royal Highness Princess Maha Chakri Sirindhorn visited the region in 1995 and began the process of establishing the Park after being impressed with the biodiversity of the area's forests (“HRH Princess Maha Chakri Sirindhorn Visiting,” 2004).

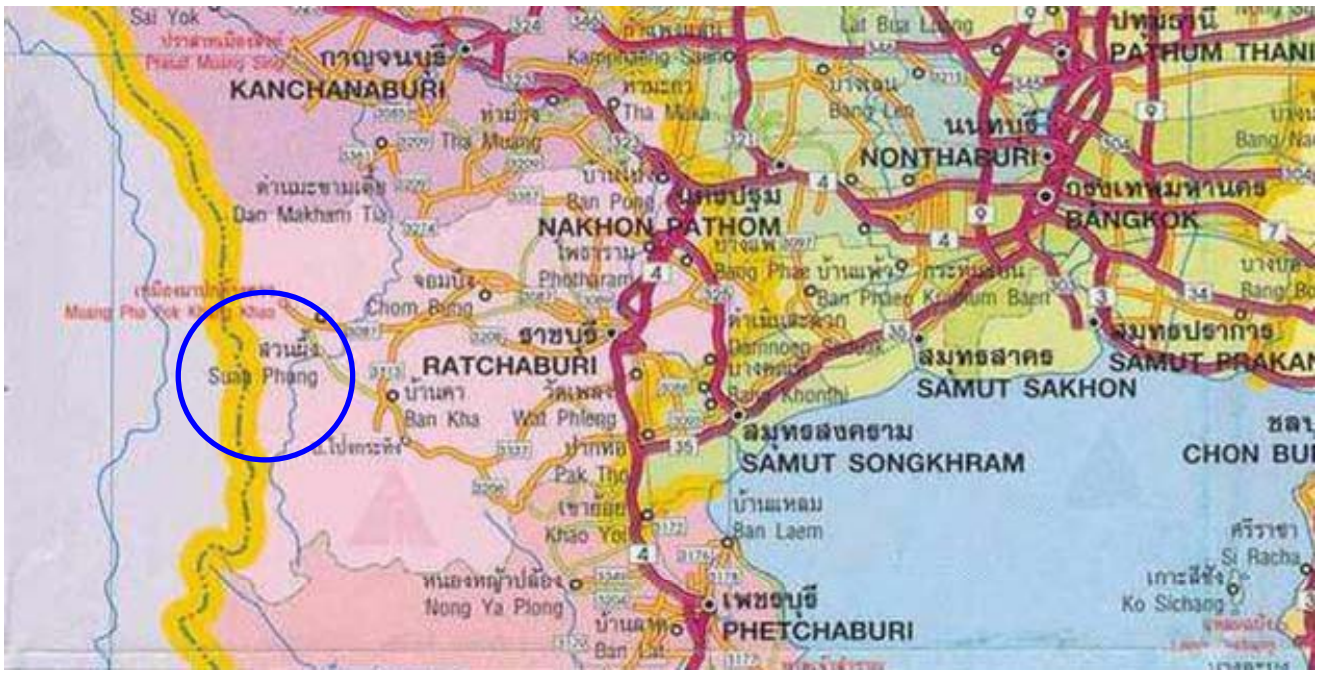

Figure 2.1-1: Location of Suan Phung Nature Education Park in Thailand (Hua Hin Travel Guide, 2005)

The Park covers 21,265 hectares (82 square miles) of land and contains the Tanowsri Mountain Range, on the border between Thailand and Myanmar. The forested area of the Park includes evergreen, deciduous, bamboo, and rain shadow forests. The Park also contains the Boe Klueng Hot Springs and the Khao Jone Waterfall ("HRH Princess Maha Chakri Sirindhorn Visiting," 2004).

Suan Phung was not heavily settled until relatively recently, when tin mining drew workers from Thailand and Burma. Tin and feldspar mining in the region has left behind desolate, sandy areas which can still be seen in various places in the Park. Until the local tin industry collapsed 15 years ago, mining supported most of the people in the region (Chakkrit, 2006). Although the commercial mines have been shut down, some local people still continue to mine on a small scale (Finch, Freitas, Hall, Roach, 2006).

2.1.1 The People of Suan Phung

The well being of the people of Suan Phung has been a primary concern of the work of HRH Princess Maha Chakri Sirindhorn. The communities in Suan Phung have developed in the midst political and economic turmoil. They have developed over two distinct periods. The first of these was during border disputes with Myanmar, when the Royal Thai Army encouraged people to move to border regions in order to claim them as part of Thailand. The second was during the

tin mining boom, when people from Thailand and Myanmar came to the area to find work. Approximately 60% of the population in Suan Phung is Karen hill tribe from Myanmar. (Chakkrit, 2006). When the park was established people were already living in the area, and as a result the Park still contains 12 villages, with a population of about 3000 people (HRH Princess Maha Chakri Sirindhorn Visiting," 2004; Chakkrit, 2006).

Following the closure of the tin mines 15 years ago, many of the workers from the mines remained in the area and turned to agriculture to make a living. Because almost all the current inhabitants of the Suan Phung area originally were employed by the mines, the farmers do not have the benefit of generations of developed farming practices, and often their methods are unsustainable (Chakkrit, 2006).

In the past five years, Suan Phung has become an attractive site for vacation homes, resorts, and large farms. Businessmen from outside the area find desirable land and purchase it from poor "owners" who do not actually have any official right to sell. The people selling their land just occupy land belonging to the government. Businessmen then purchase the land and consolidate a number of parcels. The original occupants, who now have no source of income, usually become laborers for the new owner. If they do not work for the new owners, they may begin to illegally clear new land for themselves (Chakkrit, 2006).

2.1.2 Education

There are six primary schools and one secondary school in Suan Phung. The Thai government subsidizes primary school education, but not secondary school or above. As a result, only about 45% of children in the Suan Phung area continue on to secondary school. Of those, only 20% continue on to college (Director of the Simlai Siam primary school, 2006). The ones who cannot afford to continue their education have few options. The government grants a limited number of scholarships to the most promising students, but the students who receive them must be Thai. Since 60% of the Suan Phung population is Karen hill tribe, this narrows the pool for possible scholarship candidates considerably (Chakkrit, 2006).

The only other opportunities for further education outside of secondary school are vocational schools or monastic life. The former does not lead to higher learning, but does reinforce good agricultural and occupational practices. The latter requires a strict lifestyle with limited educational advancement, and is only available to males. It can be seen why the average

education level of Thai citizens is sixth grade, or the end of primary school (Director of the Simlai Siam primary school, 2006).

2.1.3 Environmental Problems Plaguing Suan Phung

The Suan Phung Nature Education Park was developed by an initiative of HRH Princess Maha Chakri Sirindhorn. On her first visit to the Park, she recognized the diversity in the local environment, but also saw many problems causing its destruction. The major environmental problems in the Suan Phung area are:

- forest clearing,
- mining,
- unsustainable agricultural practices,
- erosion

These environmental issues will be discussed briefly in the sections that follow.

Forest Clearing

In many areas of Thailand, deforestation occurs as a result of slash-and-burn farming or illegal logging practices. All logging has been banned in Thailand since 1988, when a fatal landslide logging catastrophe occurred. Although most commercial logging has stopped, there are still many people who illegally cut trees in Thailand's forests (Hirsh, 1996). In Suan Phung, some will go into the forest at night and remove trees to sell illegally (Chakkrit, 2006). The local people who illegally log trees do not know the damage they may be causing to the environment. Logging and slash-and-burn farming destroys habitats and causes massive erosion problems. In turn, soil nutrients are depleted and topsoil is washed away. Oftentimes, the land cleared for farming loses its nutrients by lying bare for too long, preventing any highly successful crop yields when farmed. In most cases, the soil, if not completely depleted of nutrients, will be within a few crop rotations, causing the farmer to clear cut another parcel of land (Wright, 2005).

Mining

Up until fifteen or twenty years ago, tin and feldspar mining was an integral part of the economy of the Suan Phung area. Although some mining still occurs, most mines in the region are closed down, and their destructive methods have been put aside. The tin mining process involved the use of high pressure water to wash gravel and soil in sleuths where the tin was

collected. This mining process resulted in the removal of all vegetation and topsoil in the areas where mining is conducted. Many of these mining areas in Suan Phung remain as areas of bare sand. Since a majority of the Suan Phung region was developed for mining, a significant portion of it is now left unusable, because all that remains is sandy, gravelly soil (Chakkrit, 2006).

Unsustainable Agricultural Practices

Most of the original population of the area was brought to Suan Phung to mine. Therefore, they have a limited background in agricultural techniques. Poor practices, such as farming erosion-prone land and not leaving the land fallow to restore nutrients, cause the land to degrade quickly. Although many farmers practice a form of crop rotation, the practice is based on the market, rather than on restoring nutrients to the soil (Chakkrit, 2006). These practices can render a field useless in a few years. When a field becomes unproductive, a new area of forest must be cleared. Larger orchards are currently using toxic pesticides and fertilizers to protect and enhance the growth of crops (Chakkrit, 2006). These chemicals and nutrients seep into the soil and leach into local and ground water supplies affecting local wildlife (Environmental Science, 2003).

Erosion

Erosion is a significant concern in Suan Phung, because of previous mining practices in the area and poor agricultural practices (Chakkrit, 2006). Many of the people in the area are not educated in good agricultural practices that help prevent wind and soil erosion, these being contour planting, minimum tillage, cover crops, no-till, perennial plants, hedgerows, and windbreaks (What is Agriculture, 2005). Many farms and orchards are located on hillsides without using contour plowing. Rows of plants run vertically down the hill, which causes more soil erosion than most other planting techniques. Orchards also tend to have extensive irrigation, which also promotes soil erosion, because of the large amounts of water flowing through the orchard (Finch et al., 2006).

Conclusion

The four environmental problems described here represent some of the major environmental issues in Suan Phung. These problems have generally resulted from peoples' lack of consideration for their long term affects on the environment. People in the area often do not

understand the significance of their actions. The Park is currently working to improve on and cease these environmental problems (Chakkrit, 2006).

2.1.4 Suan Phung Facilities and Programs

To combat the environmental issues that result from a lack of awareness among the local populace, the Suan Phung Nature Education Park has instituted a number of programs, both to educate locals and visitors, and to repair areas that have been damaged by human actions. These programs have been developed in accordance with the goals outlined by HRH Princess Maha Chakri Sirindhorn when she first established Suan Phung. The Park's programs and facilities to address these goals include:

- vocational training;
- a visitor's center;
- a walking trail for Park visitors and locals;
- reforestation efforts
- SEED camps.

These programs and facilities are described in the sections below.

Vocational Training

The vocational training programs are an effort by the Park to give the local people the tools they need to help raise themselves above the poverty line. The Park produces dried banana products, employing local people to do the work. One vocational training program of the Park teaches locals how to safely and sanitarily make these banana products. Eight volunteers were selected to join this program and began by doing a majority of the manual labor involved in the process, much as they might do for any other business in the area. There were a couple of differences, however. First, they were exposed to good environmental and hygienic practices and taught why they were important. Second, they were only paid upon delivery of a product, rather than at the end of each day. For the banana products business, that usually means once every three days. As a result, the workers learned how to manage time and money both for buying raw materials and between pay periods. The second change alone was enough to drive away four of the initial eight workers (Chakkrit, 2006).

Over time, the volunteers' responsibilities have increased. They have slowly become responsible for obtaining a larger and larger percentage of the raw materials for the products, and for selling a growing percentage of the products. It is their responsibility to find good deals and materials, and to negotiate. Eventually, more workers are planned for the program, and the first batch of volunteers will be responsible for training and supervising the new employees (Chakkrit, 2006).

Visitor's Center

One facility used to educate visitors to the Park is the visitor's center. The visitor's center has exhibits which emphasize the value of preserving the Park along with descriptions of the involvement of HRH Princess Maha Chakri Sirindhorn. It shows how the hot springs work, the variety of rocks which can be found in the Park, many of the species of animals and plants which can be found in the Park, and evidence of ancient humans who lived in the region (Finch et al., 2006).

Walking Trail

A six kilometer walking trail, paved with stones, snakes in a circuit near the visitor's center. The walking trail passes through all four of the types of forest found in Suan Phung Nature Education Park – evergreen, deciduous, bamboo, and rain shadow forests. There are a number of signs which identify the trees all along the path, and include useful applications for each one. There is also a hot spring and a waterfall that lie along the path (Finch et al., 2006).

Reforestation Efforts

Suan Phung Nature Education Park is currently undergoing an intensive reforestation project near the visitor's center. At one point, the land there was a tin mine, the topsoil was washed away with nothing left but sand. When the topsoil in an area is destroyed or damaged, the land follows a natural progression of recovery. Grass will grow first in a barren area, and will give the soil enough nutrients and water-holding capacity to eventually allow for the growth of bamboo and similar small trees. Gradually the bamboo will add some nutrients back into the soil and the soil will be able to support larger and larger trees that have greater water demands. The Park has recreated and accelerated this process in order to reintroduce native species to the area which, until a short time ago, could no longer survive there. Foreign trees are currently growing

in the vicinity of the main buildings to restore the soil enough to grow the native tree species (Chakkrit, 2006). The progress they made can be seen by comparing one of the other former mining areas to an area undergoing the reforestation process. In the one they have worked on, there are young trees and low brush. In the ones that have not received this attention, there is only bare sand and grass (Finch et al., 2006).

SEED Camps

Suan Phung Nature Education Park has developed a series of education programs for children: the Suan Phung Environmental Education Development (SEED) camps. Currently, there are four of these three day camps, each on a different topic:

1. Water Quality (Water Rangers)
2. Learning about Trees
3. Environmental Education, and
4. Importance of the Environment (Petchkleang, 2006).

The environmental education program we developed was the fifth in this series.

The SEED programs focus on three methods for conservation education. First, science and group work are used to enhance the learning experience. Second, they use outdoor learning to best raise children's awareness and consciousness of natural resource convention. Finally, they endeavor to set up a youth conservation network in the community which unites children from multiple schools in continuing conservation work after the camp is over (Petchkleang, 2006).

All four camps contain similar activities, using methods such as stories and songs to present information to the students in a memorable form. The camps also include student-generated skits, presentations, dramas, and other activities to encourage students to think critically for themselves and use their imagination (Petchkleang, 2006). Each camp also has an activity on the second evening called "the promise". Campers write a promise on a postcard to take action in preserving the environment based on what they learned at the camp. They then send these postcards to friends or family members. This activity encourages students to brainstorm and think critically about what they can do to help conserve the environment (Chakkrit, 2006).

Conclusion

The programs described in this section outline Suan Phung Nature Education Park's efforts to achieve its goals of providing the local community with more environmental education opportunities. These programs are intended to address issues in the community and the environment. The programs directly address environmental problems and impart a sense of appreciation for the environment. They also are intended to empower people so they are in position to make decisions about the misuse of environmental resources. The Royal Projects Office is working to continuously expand and improve on these programs.

2.2 Good Practices for Environmental Education

Suan Phung's environmental education camps seek to give participants an awareness of the natural environment. The Park's approach to environmental education reflects the global recognition that this type of learning requires new techniques: traditional classroom learning is not adequate to raise students' awareness of ecological issues (Institute for Global Environmental Strategies [IGES], 2002). A number of organizations worldwide have investigated the characteristics of a successful environmental education program. These results shed light on the effective development of an environmental education camp for Suan Phung. Although specific conclusions may differ, there are many themes present across multiple reports; of these, three themes are particularly important:

1. non-traditional learning
2. tailoring environmental education to its audience
3. community involvement

These requirements for an environmental education camp and examples of their implementation are discussed in the following sections.

2.2.1 Non-Traditional Learning

Non-traditional learning is a term used to describe the method of presenting teaching materials in an unconventional way. This usually entails extracurricular, intensive, cooperative, hands-on, experimental, and sometimes out-of-the-classroom learning. When creating an Environmental Education program it is important that the curriculum extends beyond the classroom (The World Conservation Union [IUCN], 2002; IGES, 2002). Environmental

education is more concerned with changing attitudes, awareness, and skills of students than purely increasing knowledge; for this reason, traditional lecture-based learning is inadequate (IUCN, 2002). According to the IGES, the focus when teaching children should be on the development of tools that will allow them to make informed decisions later in life (IGES, 2002).

Developing an awareness and appreciation for nature is a key part of becoming environmentally conscious, and hands-on, interactive learning has long been a central and important part of environmental education because it is very effective in developing this appreciation (IGES, 2002). Care must be taken, however, to avoid the mistake of many past programs. Professor Tidimane Ntsbane of Botswana warns that, "Previous approaches assumed that by exposing pupils to nature…, their attitudes towards nature would change and they would change to become environmentally friendly and literate. Experience over time however, has shown the fallacy of this traditional thinking…" (IGES, 2002, p. 228). He goes on to say that knowledge and awareness must be the basis of environmental education, as they are the elements that provide motivation to change the status quo.

The focus today is on developing the skills to identify and propose solutions to environmental problems in youths, rather than trusting that they will gain the skills necessary to do so (IGES, 2002). Methods used to develop these skills are group work and interactive learning. These have been identified as excellent methods of improving skills such as critical thinking, communication, and cooperation (IUCN, 2002; Johnson and Johnson, 1996). The "cooperative" model of education, rather than the traditional "competitive" one, has shown to be much more productive. Comments and observations made by participants involved in a cooperative approach are often surprisingly insightful (IGES, 2002). The idea that group learning gives those involved more control over their education and educating others, is one of the reasons that this approach to learning is successful (Johnson & Johnson, 1996).

2.2.2 Tailoring Environmental Education to its Audience

Any program will have little impact if it fails to effectively connect with its audience. This phenomenon is cited as the downfall of multiple environmental education programs in a report by the IGES (2002). For an education program to be memorable and have a long-lasting effect, it must capture the attention of its participants. The factors to consider are not only short-term interests such as enjoyment, but applicability to the learners' everyday life.

The "Fun-and-Learn" approach to teaching has been shown to be effective in many cases (IGES, 2002). Games, drama, role-playing, and other interactive methods of education get participants involved in their education, and provide a fun means for students to learn from each other. These approaches have been found to be even more effective in areas which have a low literacy rate (IGES, 2002).

Another effective education method is connecting learning to the experiences of the students. One particularly powerful example of how effective this kind of approach can be has been demonstrated in India. The "Our Land, Our Life" program in India has made significant gains over the 18 years it has been running. The basis for its success is the curriculum, which is specifically tailored to the regions of the country it is deployed in (IUCN, 2002). The program cultivates a view of the environment that includes human settlements; it seeks to address local ecological issues as they pertain to the livelihood of the people. By focusing on issues that pertain directly to the participants' lives, "Our Land, Our Life" shows students and their communities the value of an environmentally conscious mindset.

2.2.3 Community Involvement

"Our Land, Our Life" also exemplifies what may be the most important component of environmental education programs: the involvement of local communities. The IGES report goes so far as to say that without a feeling of community ownership, a program is doomed to fail (IGES, 2002). The body that initiates an environmental education program is unlikely to continue to supervise every aspect of the project. At some point it will fall to members of the community to perpetuate the program. Attempting to ensure that a program stays successful through official, mandatory means will not be effective. This type of regulation rarely results in voluntary action by the community (IGES, 2002).

Involving members of the community and giving them an active role in the development and continuation of the environmental education program, on the other hand, can inspire a sense of ownership that protects a program from withering (IGES, 2002). This also can increase the flow of information provided by the educational program, and can even educate people who are not directly involved. This kind of effect has been observed at the Mochudi Education Centre in Botswana, where the students' partial direction of their own environmental education Park sparked a flow of information between teachers, students, and their parents. Through the

children's involvement, the entire community was educated about the environment (IGES, 2002).

2.2.4 Conclusion

Examination of literature on effective methods for environmental education suggests a number of approaches that can greatly enhance an environmental education program and make it more successful. Some major themes that are applicable to Suan Phung's environmental education camps are: first, that environmental education should include significant amounts of hands-on activities and experiments as well as cooperative learning so that students can be more involved and interested in the learning process. Second, that for an environmental education program to be interesting and memorable, it must take into account the experiences and interests of its audience. Third, for the program to persist for a long time, local members of the community must take some responsibility for the process.

2.3 Education Evaluation

To reinforce and strengthen any environmental education program, a means to assess its progress must be included as a necessary developmental step. An evaluation process provides a number of useful functions, the most important of which is determining the quality of the program assessed. Continuous measurement of the progress that participants make while at a camp can be used to ensure that the program is achieving its objectives, and allows the issues that inhibit its performance to be identified. In this way the program can constantly be improved.

The data generated by the evaluation process can also be used to attract new participants. Demonstrating the value of an educational program to a community or organization can draw their interest while providing assurance to current participants that the program is worthwhile.

One resource that is helpful in designing evaluation methods for an environmental education program is a book called *Evaluating Environmental Education* (IUCN 1999). It provides a 13 step process detailing planning for and implementing a study of an environmental education program (see Figure 2). This process also provides hints, tips, and examples to facilitate each step. The steps of this process can be assembled into three major groups:

1. preparation for evaluation (steps 1-6)
2. collection of evaluation data (steps 7-9)
3. analysis (steps 10-13)

These steps will be discussed in further detail in the sections below.

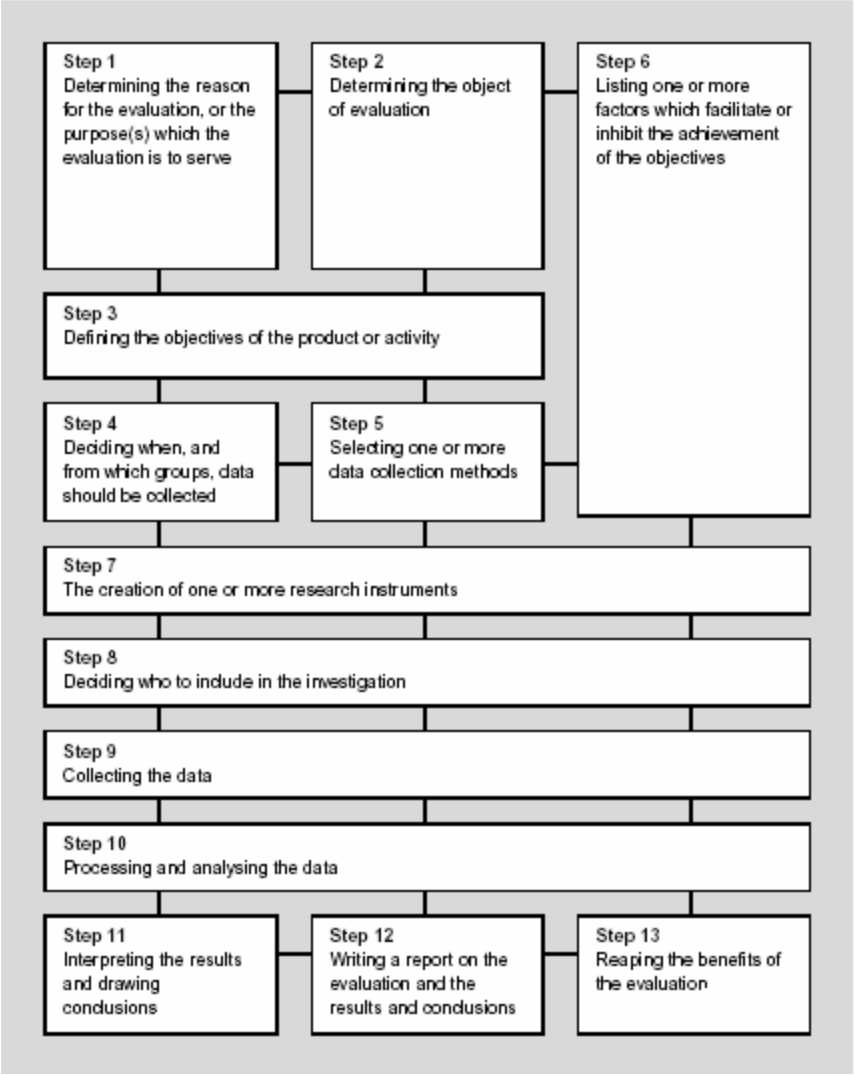

Figure 2.3-1: The 13 Steps of Evaluating Environmental Education. (Stokkings et al., 1999, p. 1)

2.3.1 Preparation for Evaluation

The first six steps of the evaluation process involve all preparation work done before evaluation. These steps are designed to help evaluators determine the important aspects of the program and establish how data must be collected. The framework places great emphasis on clearly defining the program that is to be evaluated—its overall goals, specific objectives, and its expected outcomes. These must be specified accurately and explicitly, and independent of descriptions of the activities that will seek to achieve these goals (Stokking et al., 1999). These

first six steps help the evaluator tailor data collection to measure the important parts of the program outlined by its objectives.

Data collection itself requires a significant amount of planning. What data will be collected and who it will be collected from has to be decided on first. Measuring how much children learn presents a significant difficulty, because they cannot always provide adequate feedback through traditional means such as questionnaires or interviews. An evaluation of the Suan Phung program should, therefore, rely primarily on teacher observation and tests.

An important aspect of developing evaluation methods lies with ensuring the design of the camp will produce the right results. One effective method for doing this is "Cooperative Learning," which involves using group work in a large portion of the camp's activities. According to Johnson and Johnson, this approach has a number of benefits both for assessment and quality of education (1996). Group work results in higher achievement and better attitudes among students, because they learn from each other. "It is within cooperative education that the intellectual challenge, disagreement, and controversy takes place that fuels higher-level reasoning, divergent thinking, creativity, and long-term retention" (Johnson and Johnson, 1995; found in Johnson and Johnson, 1996, p. 1:13).

The final element of preparation specified in *Evaluating Environmental Education* is identifying those factors which might inhibit the success of the program. Evaluation can identify where a program falls short of its goals, but it cannot determine what the causes of the deficiency are. Determining these beforehand makes analysis easier and more accurate.

2.3.2 Collecting Evaluation Data

The framework described in *Evaluating Environmental Education* provides tips for data collection, most of which focus on administering questionnaires to adult participants to assess their learning. A camp setting typically makes it difficult to measure the progress of students, because the desired changes are more in awareness and skills than knowledge. Traditional assessment tools are not well-suited to the interactive environment of a camp. In general, the structure of a camp is more relaxed and students are led through activities. Environmental education camps, like those conducted at Suan Phung, do not usually give grades to participants. A process similar to assigning grades must still be implemented to assess the progress of students and the effectiveness of the camp.

Cooperative learning is a method by which assessment can easily take place. It provides a structured environment that allows for assessment of students in an interactive environment, and facilitates assessment of more diverse outcomes without the need for writing. In this way, cooperative learning can fuse together the best educational environment and the assessment for it (Johnson and Johnson, 1996).

2.3.3 Analysis

There are two major concerns with evaluating the data collected from an education program for children: figuring out what the data mean, and finding a reference by which to measure the effectiveness of the program. The data gathered for the Suan Phung environmental camp will be largely qualitative in nature, and likely somewhat subjective. Also, evaluation of the camp itself will not provide enough data to determine the absolute value of the program. Results from other programs are necessary to compare the data against, or it will be of little use.

Goals and specific learning objectives established before the study are what will allow the results to be measured. Each expected outcome of the camp should be considered, and students should be scored by rough levels of achievement on each of these. These rough achievement levels can later be mapped to scores in assessment tools. The defining characteristics of each level of achievement should be clearly specified beforehand, and the defining qualities of each scoring level should be determined before data collection. This ensures that the results do not have any effect on how the levels are assigned (Johnson and Johnson, 1996). This allows a more measurable representation of the data to be achieved (Stokking et al., 1999; Johnson and Johnson, 1996).

3.0 Methodology

The goal of our project was to design and implement an environmental education program that addressed environmental issues in Suan Phung. Throughout this process, we wanted to ensure that the program fulfilled the needs of our sponsor and the people and environment of Suan Phung. In order to best determine those needs we split the task of designing the program into four objectives.

1. Observe conditions and discuss environmental stresses of the park with our sponsor
2. Research the content of the program and create educational objectives
3. Develop a curriculum for the program that to accomplish those objectives
4. Fourth, the program was run and we evaluated its strengths and weaknesses

Each of these objectives and the methods we used to research them are discussed in the following sections.

3.1 Objective 1: Develop the theme of the program by assessing the goals of our sponsor and the needs of the region.

The environmental camp we were asked to design is an extension of the services the Royal Projects Office is providing for the area of Suan Phung. This meant that the camp had to be integrated with those services and address specific problems in Suan Phung. Also, our background research found that environmental education is more effective when it is tailored to the needs and interests of the community. This contrasts with teaching about conservation on a general or global scale. Therefore, before we could decide on a theme for the new camp, the social and economic conditions of the area needed to be considered.

We used three methods to obtain the information we needed to develop appropriate goals for the program; these included interviews, site visits and archival research. First, we did some preliminary research based on some of the suggestions our sponsor made for camp topics and audience. Second, we visited the Park, and learned about the conditions and programs in the region, both from a representative of the Royal Projects Office and from our personal observations. Third, while in the Park, we visited four local schools. There, we interviewed teachers and students, and observed some of their educational curriculums. Combined, these

three sources of information allowed us to develop the overall goals for the environmental camp, including its primary topic.

3.1.1 Preliminary Research into Options for the Camp Program

In an initial meeting with Royal Projects Office staff, we were given a list of five topic ideas, and told that we could create a program for either primary or secondary school students. They also gave us some information on what the existing camp programs were like at the Park so that we could model the new camp after the existing ones. They made it clear, however, that if there was another topic or format that we preferred, that we could change any of the parameters they suggested.

We took the information they gave us, and did some preliminary research available environmental science materials to determine how detailed each topic must be. Though our research was by no means exhaustive, it allowed us to understand the breadth and scope of the proposed topics. Comparing this information to the limited preparation time and constraint of a three day camp allowed the generation of a list of viable topics. Our research also provided a few additional topics that could possibly be the focus of the camp.

Topics considered for camp theme:

Suggested by the Royal Projects Office
- Biodiversity
- Rain shadow Forest
- Soil
- Hot Springs
- Water Quality (Improving existing program or creating secondary school program)

Our Ideas
- Reforestation
- Sustainable Agriculture

We also looked into how some of these topics were presented to primary school and secondary school students. We began with basic background research on each topic. Further, we examined possible curriculums of these topics for both primary and secondary school. We wanted to determine the depth of material that would be necessary for each age group and compare it to the potential expertise of the team.

3.1.2 Visit to Study Site

In order to make the new camp program fit with the Park's work and the needs of the Suan Phung area, we needed to learn about the conditions in the Park and the programs the Royal

Projects office was running at the Park. To get this information, we made our first visit to the Park from January 17th to 19th, 2006. The itinerary for that trip can be found in Appendix B:. We were accompanied by Dr. Chakkrit, the director of the Princess' projects in the central region of Thailand.

The most important method used to learn about the goals and interests of our sponsor and Suan Phung's problems were interviews from our initial trip to the Park. He explained various natural features of the Park and details about Royal Project programs in progress. He provided information about the history of the area and how it has led to some of the environmental problems that trouble the region. As we traveled to different areas of the Park he identified the problems that he felt were important for us to know and teach about. These discussions provided us with the perspective of the Royal Projects Office pertaining to the problems in Suan Phung and the steps the office is taking to address them.

Observation was also important in identifying problems that need attention in the Park. Over the course of our stay we traveled through much of the Park area, and observed natural features, agriculture, villages, and schools. We concentrated on environmental problems and elements of how people live. Group members recorded those things that they found particularly interesting. Photos were used extensively in recording examples of the local environmental problems. These observations were used to confirm what we learned from Dr. Chakkrit, and to give us first-hand experience of the tensions the program would help to ease.

3.1.3 Visits to Local Schools

During that trip, we also conducted interviews with students, teachers, and school directors of the Suan Phung area. We visited four schools on the first trip: Bow Wee, Tako Pittong, Takola, and Simlai Siam. The educational needs of these schools were of importance to determining the goal of the camp. These interviews were informal and generally initiated by Dr. Chakkrit, who explained who we were and our purpose in Suan Phung. Teachers provided their opinions about specific problems they saw in the school's curriculum. They included input about the social issues in the area that create challenges for education.

3.1.4 Formulating the Camp's Goals

Following the trip to Suan Phung, we took the information we had gathered and compared it to the list of topics we had generated. We examined how teaching each topic would

address the needs we had discovered. From this we developed program goals that could be presented to the Royal Projects Office staff. Our final primary goal was to develop a three-day educational program on soil conservation for 5th grade students that encourages them to consider the long term effects of humans' interactions with the environment. We also identified critical thinking, teamwork, and personal investigation as important skills for students to exercise in the course of the camp. We met in Bangkok with Dr. Chakkrit; Dr. Kitti, the director of the Princess' projects office; and Somphop, one of the designers and teachers for the previous camps, to present what we had decided. They were satisfied with what we presented, but gave us an idea for one additional goal: to involve local teachers in the running of the camp.

3.2 Objective 2: Determine the factual content to be included in the curriculum.

The next step was to determine what factual content to include in the program. We needed to determine what specifically should be covered and the depth of the material taught considering our choice for a three day camp. Most of this objective was satisfied by researching soil science in existing environmental literature, but this objective also depended on the curricula of the local schools, and important environmental issues in the area. Analyzing these types of information allowed us to develop a complete list of educational objectives for the camp program.

3.2.1 Research on Soil Science

We began by conducting archival research centering on some of the more significant soil conservation problems we learned about while on our first trip to Suan Phung. Most of this information was found through educational materials published on the internet and in various text books on earth and environmental science. The topics in soil science we focused on in this research were related to deforestation and reforestation, mining, and sustainable agriculture practices. These three topics were selected from the major soil related environmental issues we identified while in the Park. Within each of the major issues there are a number of topics that can potentially be taught. Our research allowed us to create a large list of topics that the camp might teach students. The list we developed was too large to be feasibly covered in a three-day camp

program, but this was intentional. It allowed us to narrow down our topics after interviewing students and teachers about their current level of knowledge of soil conservation.

3.2.2 Determining the Current Local School Curriculum

To ensure that the information presented during the program did not repeat material which the students had already learned, we wanted to learn about the existing curriculum in local schools. We began by examining some of the national guidelines for soil education in Thai schools.

We spoke with Aacaan Pasinee, a primary school teacher at Chulalongkorn University, about the soil concepts taught in Thai primary schools. She provided us with a copy of the national curriculum. Our liaison, Dr. Siripastr, translated the science portion of the curriculum, which allowed us to see what soil information students are supposed to learn in school. Discussions we had with our sponsor suggested that the actual material covered in schools might not rigidly follow the national curriculum. To gain a more accurate understanding of what topics were already covered in schools, we interviewed and surveyed teachers and students from local schools about their specific science curriculums.

3.2.3 Interviewing Local Students

We began by interviewing local students. We did this on our second trip to the Park, from February 3rd-7th, 2006. An itinerary for that trip can be found in Appendix B:. For this objective, we were able to interview two groups of fifth and sixth graders from the Ban Huay Phaak School. In all, we interviewed 22 students in groups of 10 and 12 at a time. We conducted semi-structured interviews about what they had learned about soil science. These interviews were developed based on our previous experience in conducting interviews, which is described in detail in the third objective. A detailed description of the questions we asked and responses we received can be found in Appendix E:. Our process for determining what they learn in schools will be described in the following paragraphs; these meetings with students will be discussed further as part of Objective 3.

For these interviews, three Chulalongkorn University graduate students, Naam, Apple, and Toey, interpreted for us. Before the interviews with students, we discussed with the graduate students what kind of information we wanted from the interviews. This information allowed them to prompt students to ensure we received the right type of data.

We were interesting in gather information about what students knew in relation to the topics that we were planning to teach. We focused on where we thought the new program might overlap with the Thai National Curriculum. We had generated a list of topics that were common to both proposed teaching topics and the National Curriculum. Interview questions were designed to identify which of these topics students were actually learning about. The semi-structured interview format allowed the graduate students and us to ask probing questions when needed. While our sample of local students cannot be assumed to be representative of all students in Suan Phung, it was found that some students had little or no background in soil. This meant that the program would have to include basic soil information so all students would understand what was being taught.

3.2.4 Questionnaires and Interviews for Teachers

The student interviews demonstrated the knowledge they learned during previous environmental education camps and were able to communicate to us. It was still important to identify if they had been taught about soil topics and just not retained the information. We did not want to teach the same information or at least teach it in the same way. We wanted to find out what topics in soil science the local science teachers were teaching, and how they were teaching those topics. We also wanted to find out what each teacher had experience in, and whether they would be willing to help run the camp.

We were uncertain about the number of teachers we had access to and how much time we could spend with them so we developed a questionnaire form that they could fill out on their own time. Attached to this was a form asking for help from local teachers in running the camp. Our methods for developing, delivering, and analyzing these questionnaires to determine the information teachers were teaching will be described here; the help request forms and other aspects of our meetings with local teachers will be described in Chapter 5: Camp Design and Implementation.

The questionnaire we developed began by asking for personal information about the teachers: their name, where they taught, and the grade and subjects they taught. This portion gave the teachers some easy questions up front, and allowed us to better understand the information they provided later in the questionnaire. Next, we asked them about specific topics

related to soil science: which topics they taught, and whether they used hands-on activities and experiments to augment their teaching. We presented these questions within a table, and had the teachers check off all of the columns that applied. This format allowed us to quickly analyze some of the responses without needing translation, and ask questions when we administered the questionnaire in person. Finally, we gave the teachers space at the end of the form to give us any comments they could think of. This allowed them to give us advice on topics we may not have considered beforehand. The full questionnaire can be seen in Appendix D:.

We were able to distribute the questionnaires to most of the teachers we contacted in-person, so we conducted informal interviews in some of these sessions to learn more about trends that interested us. The checklist format of the questionnaire allowed us to identify topics that teachers taught with a variety of methods. We were concerned about topics that teachers had extensively covered. We asked questions to find out more about how and what they taught. The information collected through the teacher questionnaires allowed us to identify trends in topics that had and had not been covered in school. These trends were based on analysis of the number of teachers that taught a specific topic using lectures, activities, or experiments. The questionnaire also provided teachers' opinions about what they felt were important topics to teach. This collection was later used to provide further justification for decisions made regarding what topics to teach.

We were only able to interview teachers at two schools. However, given more time and resources it would have been good to interview more. This would have generated a more general understanding of what students are being taught. The research we did provided enough information to identify some basic trends that would be useful in determining the factual content of the camp. This was sufficient for the design of the camp because student interviews showed that they had a minimal knowledge about soil science.

3.2.5 Final Development of Educational Objectives for the Camp

Our initial research into soil science provided us with a collection of potential topics to cover. The student and teacher interviews provided us with an understanding of what students know, what they are taught, and what teachers feel students should be taught. This understanding was ultimately used to refine the list of topics generated in our initial research. We removed from our list topics that we felt would not be suitable and expanded topics that our

research suggested needed more emphasis. Working within the 3 day time constraint of the camp, we developed a list of learning objectives that would be accomplished through the teaching materials for the camp.

3.3 Objective 3: Determine appropriate teaching methods for the program.

Once we finalized a list of the topics we wanted the camp program to cover and the skills we wanted the students to practice while at the camp, we had to develop activities which would achieve our objectives for the camp. We wanted to choose activities which Thai students would find interesting and fun, but still accomplish the educational objectives we had identified. We also wanted the camp program to encourage them to think for themselves and ask questions. To choose activities that would suit the camp, we researched what has been used to teach soil in the past and what teaching methods are effective in Thai education.

We gathered this information from four different sources. First, we examined similar Thai and Western programs to get ideas for activities and lesson structures. These gave us an idea of what types of approaches might be effective in teaching the material at the camp. We wanted, however, to tailor the camp more specifically to students and conditions in Suan Phung. Therefore, our second source of information was interviews with local students. Third, we completed a number of activities outlined in the previous methods, to determine if the experiment was suitable for our target age group. We wanted to make sure that the results students saw would demonstrate the ideas we wanted. Fourth, we discussed our plan for the camp schedule with three Thai university students and the head of the Park. Their feedback prompted us to adjust some of the activities so that the program would be more effective in teaching the local children. This process allowed us to develop the curriculum for the camp.

3.3.1 Examining Curricula of Similar Programs

The first step of deciding on activities for the camp was finding examples of activities from both Thai and Western programs. We began by examining the curricula of the camps they already had at the Park. While the program we were developing would have very different activities and topics from the previous camps, we wanted to organize our activities into a structure that had already been shown to work. The information on the existing programs gave us a general idea of how much time should be devoted to lectures, educational activities, and

recreation. It also gave us examples of exercises that would work well in any environmental education camp with little modification.

Next, we did some archival research to find lesson plans and hands-on activities used to teach soil science in both Western and Thai curricula. We started by searching for teacher materials online. There are many non-profit organizations that have published environmental teaching materials online. From the material we found, we selected activities which demonstrated topics defined by the learning objectives for the camp. These searches on the internet provided us with a collection of activity ideas from Western schools.

We wanted to know if similar activities were used in Thailand, and we wanted to get examples of soil science activities used in Thai schools. Using these could make the activities at the camp more effective for teaching the local children. However, the language barrier made it difficult for us to locate this type of information. We were fortunate to learn of Aacaan Pasinee, who has written books on primary school environmental education; however, these books are strictly written in Thai. We were able to interview her, and she helped us locate activity plans in her books which would be suitable for the camp. She gave us a good idea of the types of activities and lessons that would work well for an audience of 5th grade Thai students. Her input allowed us to add to the collection of activities we were considering for the camp.

We compared the list of activities we had developed with our observations from our first trip to the Park. We developed a large list of activities that would satisfy the camp objectives and take advantage to the Parks natural features. Most of the objectives were covered by multiple activities as can be seen in Table 1; this gave us the flexibility to remove or modify activities before producing our final list. In the table below, the "X"s designate certain activities as demonstrating the corresponding objective. Maybe what you need is a table highlighting the camp objectives.

	Activity	*Just Passing Through*	*Erosion in Action*	*Soil Scientist*	*Sustainable Agriculture*	*Lectures*
Educational Objectives						
General Soil Characteritics						
understand that soil changes usually take an extremely long time				X		
understand that the soil has many layers				X		X
be able to identify physical characteristics of good soil without tools, by physical observations				X		
be able to list the characteristics of good soil				X		
Importance of Soil						
be able to list the benefits of good soil		X		X		
understand that some ecosystems rely on relatively poor				X		
know the aspects of the soil that are important to plant growth						X
Threats to Soil						
be able to identify erosion and nutrient loss as major factors in soil degradation.			X	X		
understand that human actions threaten the soil			X	X	X	X
Soil Nutrients						
to obtain knowledge about the nutrient cycle						X
to know where nutrients come from						X
Erosion						
List ways to protect against erosion		X			X	
be able to identify some reasons why plant cover makes soil resistant to erosion		X			X	
Reforestation						
be able to recognize that soil in reforested are is much better than that of other areas (tin mines)				X		

Table 3.3-1: Activities in the Camp and the Educational Objectives they satisfied

3.3.2 Interviews with Local Students

Researching existing environmental curricula provided a basis for the teaching methods to be used in the camp. We still needed further justification that the methods we were choosing were appropriate. We wanted to learn what students in Suan Phung enjoy, and what teaching methods had been effective. We learned about both of these through semi-structured interviews with the local students during our first two trips to the Park. In total, we visited 4 schools, and talked to about 55 students in groups of 7 to 12 at a time (at one school, we split the students we talked to into 2 groups).

Learning about teaching methods from students was a primary focus of our first trip to Suan Phung. We conducted semi-structured interviews with Dr. Chakkrit acting as our interpreter. Prior to visiting the schools we had discussed extensively with him our plans for the project, so he was able to provide extra information to the interviewees when necessary. At each school, we talked to a group of between 7 and 10 students who had attended one of the other environmental education camps at Suan Phung. We asked them a similar group of questions. These focused on finding out what type of learning activities they enjoyed, and the teaching methods used for lessons that they remembered a lot of material from. Since we had access to the curriculum of the Park's water quality camp, we focused primarily on what students learned during that program. We also asked a number of general questions about their interests, such as what subjects they enjoyed and what they wanted to be when they grew up. Details about the questions asked and student responses can be found in Appendix C:.

Despite enthusiasm from everyone we interviewed, we discovered that getting the exact information we wanted was difficult. Even with the help of translators, sometimes our questions did not get the desired response, and sometimes we got a response we did not understand. To combat this, we developed a habit of asking questions multiple ways, and confirming each response by re-stating in our own words how we understood the response. These methods allowed us to correct initial misunderstandings of an interviewee's response.

The interviews we conducted with students on the first trip also demonstrated that it was possible to interview students and learn valuable information. Before this point, we had been worried that the difficulties of interviewing children would be too great. We asked students "warm up" questions so they would become comfortable talking with us. Results might be skewed because in any group there might be only a few students who would consistently

respond. Sometimes, Dr. Chakkrit had to prompt students to respond to questions pertaining to what they liked in school and the previous camp.

We were able to analyze the interview responses gathered during both the first and second trips and identify specific activities that students enjoyed, particularly those from the water quality camp. These activities were identified based on their frequency as a response. This information was used to verify that the activities we were choosing for the camp would be appropriate and enjoyable. Responses regarding what students enjoyed for school subjects and fun allowed us to develop a rough qualitative understanding of what the students like to do, which was useful in designing some elements of the camp curriculum.

3.3.3 Trial Runs of Activities

After developing and refining a list of activities for the camp we verified that they could be effectively run using the natural materials in Suan Phung. Many of the activities had been originally developed for Western forest soil conditions. We had to test the activities and make necessary changes to ensure that they would work in these different conditions.

While on the second trip to Suan Phung, we ran each of the activities on our final list. We used materials just like what the students at the camp would use, including similar soil samples. Some of the activities had to be tried a number of times with slight changes before we observed the results described in the original activity descriptions. We recorded the steps we took for the most successful tests, including taking pictures of the experiment set-up. We also took note of the time it took to run the experiments. This information was eventually used to develop final instructions and the camp schedule.

There were a few activities with which we encountered considerable problems when we tried to conduct them in Suan Phung. These activities were based on exploring insects and other living organisms in the soil. Analysis of why these activities would not work led to discoveries about the soil in Suan Phung, particularly that the soil was poor, dry, and very compacted. These discoveries guided the development of new activities, which were consequently tested during our trip. A full description of some of these activities can be seen in the final camp materials in 0. Specifics of their design will also be discussed further in Chapter 4.0, and details of their implementation are described in Appendix A:.

3.3.4 Schedule Proposal and Feedback Sessions

All of the above methods allowed us to develop a tentative schedule of activities for the camp. We also wanted some feedback on our plans from people who had previously attended or run Thai camps. A large concern of the camp program was the adaptability of western ideas to Thailand and miscommunication between English and Thai. Thus, we presented our ideas to three groups: 1) local teachers; 2) Naam, Apple and Toey, the Chula students who accompanied us on our second trip to Suan Phung; and 3) Khun Suthep, the head of the Suan Phung Nature Education Park staff. In each of these meetings, we presented the tentative schedule. We then described each of the elements, giving a brief description and discussing the goals of each activity. Throughout this process, we observed our audience, gauging their reaction to each element. We allowed them plenty of time to respond, but specifically asked for feedback at intervals if our audience was not responding verbally. The responses we received included activities we could add that Thai children would expect in an environmental education camp, such as a formal opening ceremony and a vow ceremony. They also helped us place the periods we planned for fun and relaxation into better points in the schedule for the students. This feedback process was another step in verifying the teaching methods we were going to use. Details and the development of the individual activities can be found in Appendix A: and Chapter 4.0.

3.3.5 Development of a Final Camp Schedule

Research into existing curricula and past camps in Suan Phung along with our list of learning objectives provided a schedule framework and tentative list of activities to be used at the new camp. Information from student interviews provided justification for the types of activities being proposed. This information was used to further refine the camp schedule. This refined schedule was then verified through trial runs of activities and feedback from local teachers, Chula graduate students, and Park staff. This verification process guided the development of the camp schedule that was used in the first trial run of the camp. This schedule can be found in Appendix G:.

3.4 Objective 4: Evaluate the gains made by students on the established camp objectives.

In order to measure how well we accomplished our goal and to provide recommendations for future educational programs, we needed to evaluate the program. We developed a pre- and post-test in order to assess the change in knowledge that occurred as a result of the program. We also created observation sheets that were distributed to Chulalongkorn University students helping us run the camp. These provided us with more detailed information about each of the activities. We developed a questionnaire for local teachers attending the camp, with the intention of giving it too them at the conclusion of the camp. During the implementation of the camp however, we found that this information was gathered much more effectively through daily group feedback sessions. Finally, we used our personal observation of students' reactions to and enthusiasm toward program activities to provide further support for our conclusions from the other methods.

3.4.1 Pre- and Post-test

A test given at the beginning and end of the program was used to measure the knowledge gains by students while at the camp. Previous camps run buy the Royal Projects staff administered similar tests which confirmed this method as an acceptable means for evaluation. The questions on the test examined students' knowledge of the topics outlined in the educational objectives previously defined. The pre-test can be seen in Appendix H:.

We were concerned while using this evaluation tool that it would affect the success of the camp. A formal test administered at the beginning of the camp could spoil the fun spirit we wanted for the camp, and poor performances could discourage the students. Also, an identical test given at the end of the program might show artificially low scores because students would recognize the test, become bored, and not try as hard. However, we wanted some elements that we could only get from a tool like this: ease of measurement, and accuracy of data. We tried to address some of the issues with giving a test by having instructors explain that the test was not being graded and was only intended to tell us what students are learning.

Following the conclusion of the camp, we had the Chula students helping us grade the pre- and post-tests. They graded responses on a scale of 0-3. With 0 being no response or completely wrong and 3 being an excellent answer that identifies all the elements asked for in the

question. Test scores were then calculated and the overall average final scores for the pre- and post-test were compared. We used this analysis to gauge the overall effectiveness of the program. Scores on individual questions were also compared to identify specific areas of instruction that could be improved.

3.4.2 Observation Forms

To identify the characteristics of each of the activities that led to particularly effective and ineffective instruction, we needed more detailed information about students' involvement throughout all of the activities. For these data, we developed standardized observation sheets and distributed them to the Chulalongkorn University graduate students that accompanied the groups of children in each activity. The sheets asked them to recorded observations about how involved the students were at specific intervals throughout the course of each activity. Each observation form also prompted them to add their own specific comments about trends they saw. The observation form can be found in Appendix I:.

The observation forms were designed to be simple and quick to fill out. The goal was for instructors to be able to fill out the forms while instructing. The actual task of instructing at the camp, however, turned out to be much more involved than we had anticipated. Instructors were only able to devote a limited amount of time to observing because they were constantly engaged in teaching. We were able to collect observation data for three activities during the camp. This information was then analyzed by categorizing how students' engagement changed over the time period of an activity.

3.4.3 Teacher Program Evaluation Forms and Daily Feedback Meetings

Local teachers were included in the implementation of the camp in hope that they will be able to run future camps, and that they might include some of the material they saw in their classrooms. Prior to the camp we had developed an evaluation form to collect information on local teachers' opinions of the camp. During the running of the camp, however, we found that a much more effective way of gathering this information was to have daily feedback sessions. These meetings were held following the conclusion of activities each day. They included everyone who was involved in providing instruction and running of the camp. Chulalongkorn students, Dr. Siripastr, Park staff, Rabbit in the Moon staff, Royal Projects Office staff, and we were all present to provide input. The meetings were generally conducted in Thai and translated

to us. Camp staff provided input that was given based on first hand experience in instructing the activities. This provided a huge amount of information about specific elements of the camp that needed to be improved or changed.

3.4.4 Personal Observations

Our personal observations were also valuable in gauging the reaction and involvement of students throughout the camp. Though we do not speak Thai, we could still collect some of the same information about student involvement and interest as the observation forms would provide. For our personal observations, we kept unstructured observation logs. We also took pictures and video of activities. During the camp, we split up and each of us followed one group around the program to ensure observations were completed at each activity.

These methods allowed us to corroborate data from other evaluation methods, as well as to collect information not covered elsewhere. The unstructured observation format gave us the opportunity to collect information we had not anticipated before the camp was implemented. We were also able to identify things like occasions where the instructors had difficulty performing a demonstration or activity, or looked to us for help. We did not want to ask for this type of information on a formal observation form, because we wanted those to focus on the positive. Picture and video data allowed all of us to examine situations that only one of us could observe, and to discuss our observations for the same scenes.

3.4.5 Analysis

These four methods gave us a good idea of the strengths and weaknesses of the program we developed. Raw data on the success of the camp in achieving its educational objectives was obtained from the pre- and post-test data. While this information does not show how well the students retained what they learned, it still provides information about what topics in the camp were taught effectively. Observation information from observation sheets and our own, as well as input provided through feedback sessions, were used along with test data to identify areas where the camp could improve. We were able to get an idea of which activities were exciting, which were confusing, and which were boring. The various methods used in evaluating the camp were used in conjunction because there is a clear degree of subjectivity or potential error in all of them. Using information from all the objectives has allowed us to develop substantial and supportable findings.

3.5 Conclusion

Dividing our project goal into smaller objectives provided us with a means to systematically conduct research. In order to develop a program with the specific to the needs of Suan Phung, we had to decide what environmental issues were the most important in the area. This allowed us to determine what program topic would be most beneficial to the area and find the information necessary to increase the knowledge of the students on this topic. To present this information in a user-friendly way, we created Table 3.5-1. The table lists the sub-objectives in italics and the methods used for them underneath each objective. This allowed us to determine which teaching methods would be most successful, and ensure a lasting impact on the students. Finally, we assessed the knowledge the students gained, so we could make changes to the camp curriculum and provide final recommendations for our sponsor. Gathering accurate and useful information was a principal concern throughout each of these steps. We used several methods to gather the most critical data and ensure the accuracy of our findings. The methods we used to gather and validate our data provide us with confidence in our findings and results.

Objective 1: Develop the theme of our program by assessing the goals of our sponsor and the needs of the region.	**Objective 2: Determine the factual content to be included in our curriculum.**	**Objective 3: Determine appropriate teaching methods for our program.**	**Objective 4: Evaluate the gains made by students on the established camp objectives.**
Preliminary Research into Options for the Camp Program	*Research on Soil Science*	*Examining Curricula of Similar Programs*	*Pre- and Post-test*
Royal Projects Office, internet resources, text books, interviews	internet resources, text books,	previous Suan Phung camps, archival research (lesson plans)	students
Interviews	*Determining the Current Local School Curriculum*	*Interviews*	*Observation Forms*
Dr. Chakkrit, Suan Phung teachers, students and school directors	national curriculum, Aacaan Pasinee, Dr. Chakkrit	local teachers an students	camp participants (not students)
Formulating the Camp's Goals	*Interviews*	*Schedule Proposal and Feedback Sessions*	*Program Evaluation Forms and Daily Feedback Meetings*
goals of park, Dr. Chakkrit, Khun Sompop, Dr.Kitti	local students and teachers	local teachers, Chula graduate students, Khun Suthep	teachers, staff, instructors, Rabbit in the Moon, Chula grad students
	Questionnaires	*Development of a Final Camp Schedule*	*Personal Observations*
	teachers	existing curricula and previous camps	us
			Analysis

Table 3.5-1: Methods Used for Each of the Research Objectives

4.0 Findings & Discussion for Design of the Camp Program

The goal of this project was to design, implement, and evaluate an environmental education camp for Suan Phung Nature Education Park. Our research toward this goal can be divided into two parts: research for design of the camp program, and evaluation of the camp program. The first of these will be discussed in this chapter, and our findings from evaluation will be described in Chapter 5.0.

Our first three objectives described in Chapter 3.0 produced a number of findings that informed the design of the camp program. Seven major findings were used in the final design of the camp:

1. The new camp should target primary school age children.
2. People in the Suan Phung area often do not adequately consider the long-term effects of their actions.
3. Soil conservation is a good topic for a camp program in Suan Phung.
4. The camp should focus on three major topics in soil science: basic soil science, erosion, and sustainable agriculture.
5. The most important concepts taught in the camp should be taught with hands-on activities and experiments.
6. Local teachers should be involved in the implementation of the camp.
7. Certain activities from other Thai camps are essential pieces of any camp program in Thailand.

These seven findings will be discussed further in the following sections.

4.1 The new education camp should target primary school age children.

Of all the age groups available to design an environmental education program for, primary school students were the best candidates for the environmental education program we were designing. Our sponsor gave us the option of creating a program for either primary or secondary school students. Investigation into environmental education literature, discussions with our sponsor, and interviews with educators led us to decide that a camp targeting primary school students would likely be more effective in achieving the long-term goals of the Park. We also decided that this would be a more realistic goal for our project.

The long-term goals of the Park include changing the habits of local people to both improve their lives and to protect the environment in Suan Phung. Programs for children advance this cause by inspiring awareness of environmental issues before they are too set in their beliefs (IGES, 2002). We decided that a primary school program would advance this goal further than a secondary school program for two reasons. First, it was Dr. Chakkrit's opinion that younger students learn faster and are more likely to believe what they are told than adolescents or adults. Our background research leads us to agree with this viewpoint (IGES, 2002). Second, we learned from the director of the Simlai Siam School that only about 45 percent of primary school students in Suan Phung will continue their education in secondary school. Primary school is the one time where many of them can learn about important environmental issues that are plaguing their region. Students in primary school would have to be targeted in order to reach as large a population as possible. This was the biggest determining factor in our choice of age group.

Our choice was also influenced by the depth of material we would have to put into the camp. A program for secondary school students would require a greater quantity of information, and more detailed information. We felt that it would be difficult for us to attain the level of expertise in soil science necessary to develop a secondary school program in the time we had.

4.2 People in the Suan Phung area often do not adequately consider the long-term effects of their actions

During our research, we discovered that students in the Suan Phung area could benefit greatly from instruction about the long term effects of their actions in relation to the environment. Upon visiting Suan Phung and talking with Dr. Chakkrit, it was found that many of the local people practice subsistence living. Their daily lives do not require them to consider long-term financial situations or environmental impacts of their actions. The Park has vocational training programs to support planning for the future by local people; however, many people do not understand the benefits of saving money or long-term profit. Many are mainly concerned with earning money immediately and not about how their actions can degrade the land they rely on.

Dr. Chakkrit described to us a process that occurs in many places throughout Suan Phung that illustrates this situation. An outside developer will "buy" land from a local subsistence farmer, giving them a large lump sum as payment. While these funds could support most people

in the area for months, usually people will use the money to buy something new and expensive, such as a motorcycle or television. They do not consider the upkeep cost associated with such an item. These costs make them poorer than when they started (Chakkrit, 2006).

This is an example of a situation that could be avoided by considering future consequences of their actions, rather than immediate monetary gains. A similar attitude also leads many to make decisions that result in environmental degradation. In agriculture, it can lead to the misuse of fertilizers and pesticides, and use of poor field layouts that promote erosion. Due to these types of choices, there are areas in Suan Phung that can no longer support crops (Chakkrit, 2006). This convinced us that the lack of future planning was a serious concern for the area. Our background research suggested that this issue could be addressed by education programs for students (IGES, 2002).

4.3 Soil conservation would be a good topic for a camp program in Suan Phung.

The initial list of topics possible for the program, given to us by our sponsor, included the options of soil conservation, biodiversity, hot spring ecology, rain shadow effect, and wildlife. A number of small findings allowed us to decide on soil conservation as the topic for the new camp. The evidence that led us to this decision were:

1. Soil degradation was one of the major environmental issues facing Suan Phung.
2. The curricula of local schools do not adequately cover soil science.
3. High-quality sample teaching materials are widely available.
4. Soil conservation connects with topics already being taught at Suan Phung education camps.
5. The other suggested topics are less suitable for the proposed camp program.

These five sub-findings led us to choose soil conservation as the topic for the camp program. Each of them will be discussed further in the following sections.

4.3.1 Soil degradation is one of the major environmental issues that Suan Phung faces.

Our visits to Suan Phung demonstrated to us that soil degradation is a serious problem in the Suan Phung area. We learned this information from discussions with Park and royal projects office staff. Our own observations supported their descriptions.

We interviewed Khun Suthep and Dr. Chakkrit about the soil resources in the park. Khun Suthep told us that poor soil is a problem throughout the Suan Phung area. He identified practices such as tin mining and poor agricultural methods as contributors to the problem. Dr. Chakkrit also told us that the poor soil quality in the region is largely due to tin mining and agriculture.

Our observations in the Suan Phung area supported these statements. We examined soil in seven locations near the park office, and found that much of the soil is hard packed and sandy with little organic matter. Also, most of the soil is dry, a direct result of rain shadow. Moisture coming across the Tarin Sai Mountains is released on the Myanmar side of the mountains, leaving little or no rain for the valley of Suan Phung. We also noticed that most of the soil lacked soil flora and fauna, even in forested areas. This indicates an unhealthy soil ecosystem (Wright 2005).

Tin mining was a major industry in Suan Phung and resulted in the loss of what little topsoil was present in some areas. Evidence of the tin mines can still be found even in areas which have not been mined for 50 years. We found sandy run-off from the mines in slag piles and dry streambeds in the area around the Park office. Few plants grow in these areas, as the soil is devoid of organic material and does not retain water.

Poor agricultural practices have degraded the soil in many other areas. We observed many areas of the Park that were clear cut and burned to make room for farms. We also saw fields on hillsides with exposed soil and furrows running parallel to the slope. These methods of farming allow wind and water erosion to quickly strip the land of its topsoil, rendering a field useless in a few years (Wright, 2005). We also saw large orchards, which Dr. Chakkrit told us use pesticides that seep into the soil. They pollute the groundwater in the region. He also told us that farms in the area are constantly expanding, partially due to soil degradation.

4.3.2 The curricula of local schools have not adequately covered soil science.

Our decision of soil science as the topic for the camp was further reinforced by what we found out about what is taught in local schools. From interviews with students and a teacher survey, we found that soil science was not thoroughly taught in the local school system. Furthermore, what is taught on soil is presented largely through lectures, and is not very effective.

Our interviews with local students indicated that they learned a modest amount about soil science, but retain little of what is taught. Students could recall some soil science topics they had learned, such as erosion, but could not describe these topics in more detail. Interviews with teachers and students revealed that very little time is spent in schools on important local issues such as erosion or sustainable agriculture. Director Cheelio of the Ban Tagolang school told us, "schools don't have a lot of lecture information on soil, so [a soil program] will be appreciated".

Teacher surveys reinforced that erosion was not taught at most local schools (see Figure 4.3-2). It was indicated that most schools teach about entire ecosystems and do not get specific enough to focus on one topic, such as soil. The surveys also showed that the majority of these topics are taught only through lectures (see Figure 4.3-3). Previous research suggested that this is a less effective technique than hands-on activities and experiments (IGES, 2002; IUCN, 2002). Our informal interviews with teachers after administering the survey revealed these methods were not widely used because they do not know hands-on activities or experiments for teaching soil science.

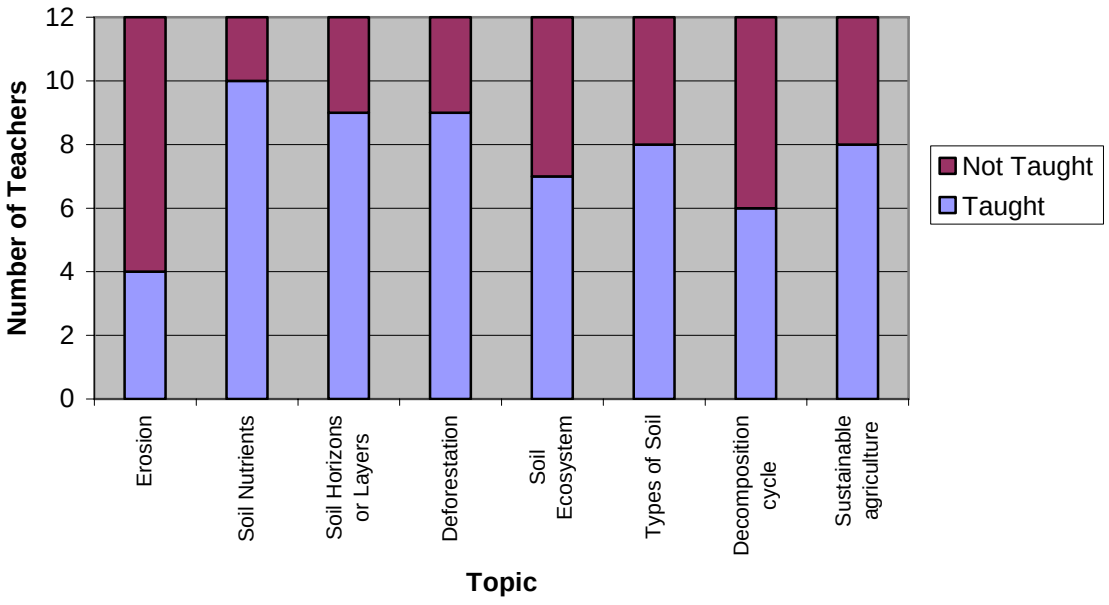

Figure 4.3-1: Soil Science Topics Taught by Suan Phung Primary School Teachers

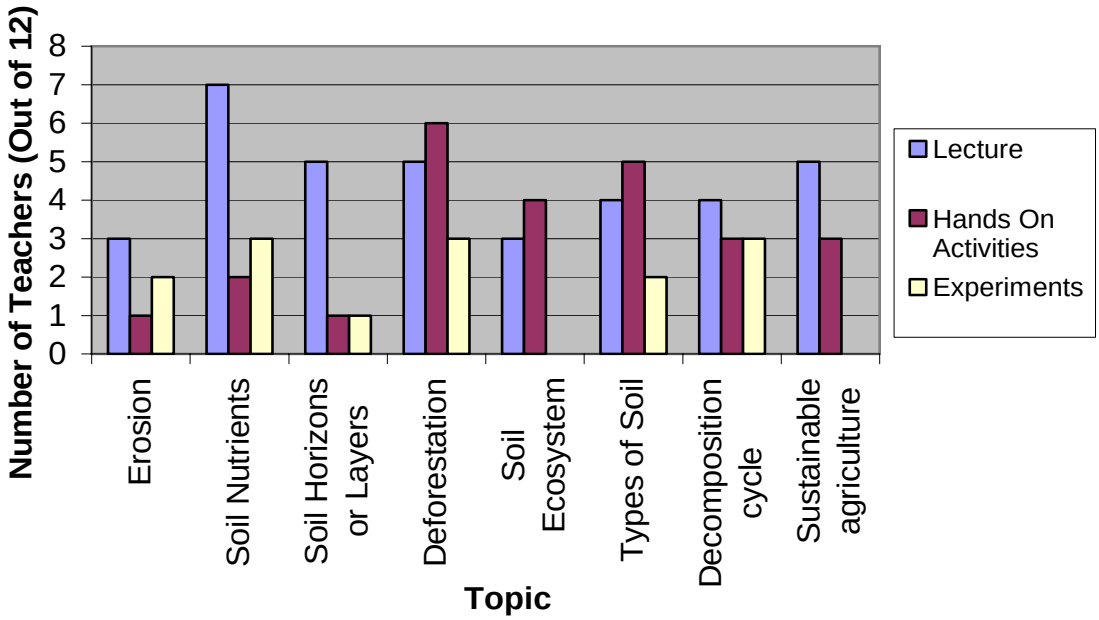

Figure 4.3-3: Methods Used by Suan Phung Teachers to Teach Soil Science Topics

4.3.3 The topic of soil conservation connected to topics already taught in Suan Phung education camps.

We found that soil conservation linked to many of the other programs in the park. We found this through examination of soil science lesson plans and literature, and the curricula of other camps in Suan Phung. We also learned from discussions with Dr. Chakkrit that the Park is working on a soil restoration and reforestation program. This was a particularly important finding because we wanted the new camp to integrate into and be an extension of the existing programs at the Park.

The subjects of the four existing camps at the Park were water quality, trees, the importance of the environment, and environmental education. Each of these is connected to soil conservation. Our research into soil science revealed that soil and water quality are entwined in many ways. Runoff causes pollutants in soil to contaminate water sources, and excessive erosion puts large amounts of sediment into streams and rivers (Wright, 2005). Deforestation is a leading cause of erosion, and trees can speed the recovery of soil. Both of the last two camps had brief exercises related to soil. None of the programs focused on soil, but any students who had taken one of the other camps would be reminded of what they learned while participating in a soil conservation camp. This would allow the soil conservation camp to build on and connect to the knowledge students learned in other camps.

4.3.4 Other suggested topics were less suitable for the proposed camp program.

We examined literature for all four of the topics suggested by our sponsor as well as two derivative topics we developed: agriculture and reforestation. We considered the pros and cons of each topic. We found that soil conservation was the most suitable of these six topics for the new camp program. Our findings for each of the six topics are summarized in Table 4.3-1, but will be discussed in further detail below.

Topic	Pros	Cons
Soil conservation	• Connects to many other topics • Important to the region • Easy to prioritize and choose sub-topics	• Could be boring • Topic too broad for a three-day camp
Biodiversity	• Links to other programs in the park	• Too broad • Difficulties in condensing-either too much information or too much overlap with existing camps
Hot Spring Ecology	• Interesting and exciting phenomenon	• Not much available material • Isolated phenomenon • Would not connect to students' lives
Rain shadow effect	• Important to Suan Phung's ecology	• Cannot be observed in a three-day camp • Interactions between humans and this phenomenon are very complex
Wildlife	• Children are fascinated by animals • Animals are obvious indicators of the health of an ecosystem	• Specimens are hard to find-would require night expeditions or captive animals.
Agriculture	• Major occupation in the Suan Phung area • Students would be able to take action on their new knowledge immediately	• Overlap with existing agriculture programs in schools • Did not fit into park theme of preservation and restoration of natural ecosystems
Reforestation	• Interesting angle on soil science • Park is doing work in this area	• Very narrow subject • Might overlap with existing tree camp

Table 4.3-1: Pros and Cons of Each Topic Considered for the Environmental Education Camp

Soil Conservation

The positive points of a soil conservation program have already been discussed. However, there were a couple of significant concerns. First, soil is a rather broad topic, but our study into soil science literature revealed that it wouldn't be too difficult to choose important sub-topics to teach that would fit into a three-day camp. Second, we worried that a soil program would be boring for local students.

Biodiversity

Biodiversity is an important part of the founding of the camp, and links to other programs in the Park. However, it is simply too broad a topic for a three-day camp. To be suitable for the type of camp program we were trying to create, it would have to be condensed or narrowed. If it were condensed into a three-day program, there would be too much information for students to process. If it were narrowed, it would most likely overlap too much with the existing tree program, or become a wildlife camp.

Hot Spring Ecology

Hot spring ecology looked to be an interesting and exciting topic to cover. Students would be fascinated by the phenomenon, and be interested to learn how it happened. There were, however, two major issues with this topic. First, there was not much material available on hot springs suitable for primary school age children. Second, hot springs are a relatively isolated phenomenon. The conclusions that could be drawn from a hot spring program would not connect to students' everyday lives. This alone disqualified hot springs as a topic, since we wanted the new camp program to be part of the Park's programs to change the habits of local people.

Rain Shadow Effect

While the rain shadow effect is an important part of Suan Phung's ecology, it was completely unsuited to the type of camp program we were trying to produce. First, the phenomenon would be almost impossible for primary school students to observe during a three day camp. Second, the rain shadow effect would be difficult for students to identify with, unless the camp focused on the fragility of the ecosystems it produces. These two findings allowed us to conclude that a rain shadow camp would be boring for the students.

Wildlife

The idea of a wildlife camp was appealing. Most children are fascinated by animals, and they are interesting subjects to study. They are also rather obvious indicators of the health of an ecosystem, and habitat loss is an easy issue to discuss with students. However, both we and our sponsor were concerned that finding animals to study would be a difficult and possibly

disappointing process. Most likely, Park staff would have to collect specimens, or students would have to venture out at dusk in an attempt to spot animals in the wild.

Agriculture

Agriculture was a topic that we identified as a derivative of soil and water quality camps. We liked the idea because most people in the Suan Phung area earn a living through farming. Most students would be able to identify with the subject matter, and would be able to take action on what they learned immediately. However, local schools already had an agriculture program, and we were concerned that a camp on the same topic might overlap too much with that curriculum. Also, we felt that agriculture did not fit into the existing programs at the Park. Most of the existing programs were focused on preservation and restoration of natural ecosystems.

Reforestation

Reforestation was another topic that we developed as a derivative of soil conservation, which incorporated biodiversity and rain shadow effect. We felt that this angle on soil science could make the topic more interesting, and get students involved in and excited about the work of the Park. However, when we considered this topic more carefully, we decided that focusing on reforestation narrowed the topic too much. A program on this topic would likely have to overlap too much with the existing "Learning about Trees" camp in order to fill a full three-day program.

Summary

Examining each of these topics allowed us to quickly narrow our choices to reforestation, wildlife, and soil conservation. Of these, soil conservation seemed best suited to what was needed for a three-day camp. We felt that the minor concern of the topic being too dull could be overcome by carefully choosing the activities for the camp.

4.4 Basic soil science, erosion, and sustainable agriculture should be major topics taught at the camp.

As previously stated, we were concerned that soil conservation was too broad a topic for a three-day camp program. Therefore, we identified three major sub-topics for the camp: basic soil science, erosion, and sustainable agriculture. These were chosen because of two sub-

findings. First, both erosion and sustainable agriculture are particularly important to the Suan Phung area. Second, all of these topics are poorly covered in local schools. Each of these sub-findings will be further discussed in the following sections.

4.4.1 Erosion and sustainable agriculture are particularly important to the Suan Phung area.

Our research into conditions in the park revealed that erosion and agricultural practices are important causes of soil degradation in the Suan Phung area. Two major stresses on the soil in the region are tin mining and poor agricultural practices. We learned this through interviews with park staff, and confirmed it with our own observations.

As discussed in section 4.3.1, discussions with Park staff revealed that soil degradation is a major concern in the Suan Phung area. Park staff also told us that the problem is largely due to poor agricultural techniques and tin mining. Dr. Chakkrit described to us the destructive tin mining methods used in Suan Phung that caused extreme erosion damage. This is discussed in more detail in section **Error! Reference source not found.**. We observed on our trips to the park that old tin mining areas support very little plant life. The soil in these areas was also observed to be sandy and dry. These observations reinforced what we learned from Dr. Chakkrit and park staff.

Unsustainable agricultural practices continue today, and we observed some while we toured the Park. These included furrows planted parallel to the slopes of hills, and soil left bare after forests were cleared and burned. Both of these practices promote erosion (Wright, 2005; Bauder, 2002). Dr. Chakkrit described the unsustainable agricultural practices that are discussed in the background chapter, section 2.1.2. He told us about how they contribute to land and soil degradation. This problem is exacerbated by what we found in an earlier finding: that people in the area do not consider the long-term effects of their actions, and they use their land for the greatest short-term profit.

4.4.2 All of these topics are poorly covered in local schools.

Our investigation into what students in Suan Phung are learning about soil revealed that none of these three topics are covered very well in local schools. The national curriculum for Thailand requires lessons on soil science in primary schools; however, the subject is either not

extensively covered, or not presented in such a way as to be memorable. We learned this through interviews with students and a survey of local teachers.

Our interviews with local students on their knowledge of soil science was intended to determine their understanding of more complicated soil topics, such as erosion and sustainable agriculture. We found that although the local schools we visited have an agriculture program, the environmental impacts of erosion are not discussed in that program. The fifth year students that we interviewed from the Ban Huay Paak School related that they knew a little about erosion. The sixth year students from the same school claimed to have previously learned about erosion, but they were unable to describe in detail what they had been taught. Some students claimed to know a limited amount about good farming practices to prevent erosion, but did not know about how plants function to protect soil loss. In fact, they recalled so little soil science information that we decided that the camp would need to include some basic soil science information and an overview of why soil is important.

Students from a single school were not a large enough sample to make conclusions about all the students in the area; however, the students we interviewed were possible participants in the new camp. To participate in the activities we were considering, all of the students would have to understand some basic soil science. Therefore, finding that any students at the camp might not have a background in soil science meant that topic would have to be included in the camp program.

We also found out the extent to which soil is taught in schools through a questionnaire given to local teachers. The results for that questionnaire can be seen in Figure 4.4-1 and Figure 4.4-2. We found that erosion, which our research determined was an important topic in soil science, was the topic covered least by the teachers we questioned. The numbers for sustainable agriculture were surprisingly high, but further investigation into those data revealed that the title for that subject was likely misunderstood as a result of translation or phrasing errors. The surveys asked the teachers to write a detailed description of the agriculture program at their respective schools. The data from these questionnaires can be seen in Appendix E:. Based on these descriptions, we found that these schools did not adequately cover soil conservation techniques in their agriculture program, prompting us to cover this topic in the camp we designed.

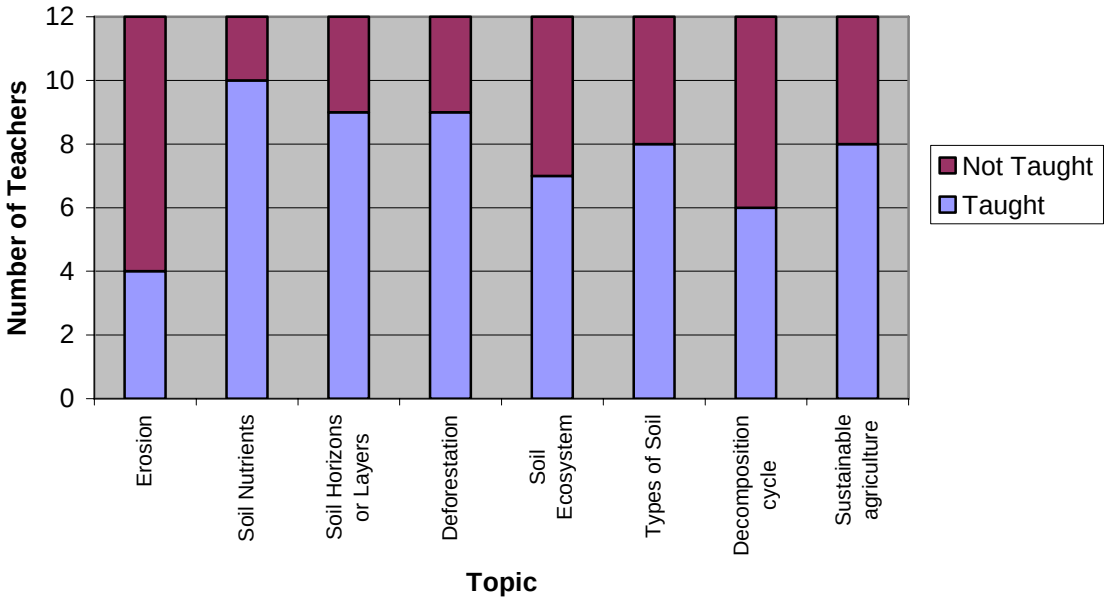

Figure 4.4-1: Soil Science Topics Taught by Suan Phung Primary School Teachers

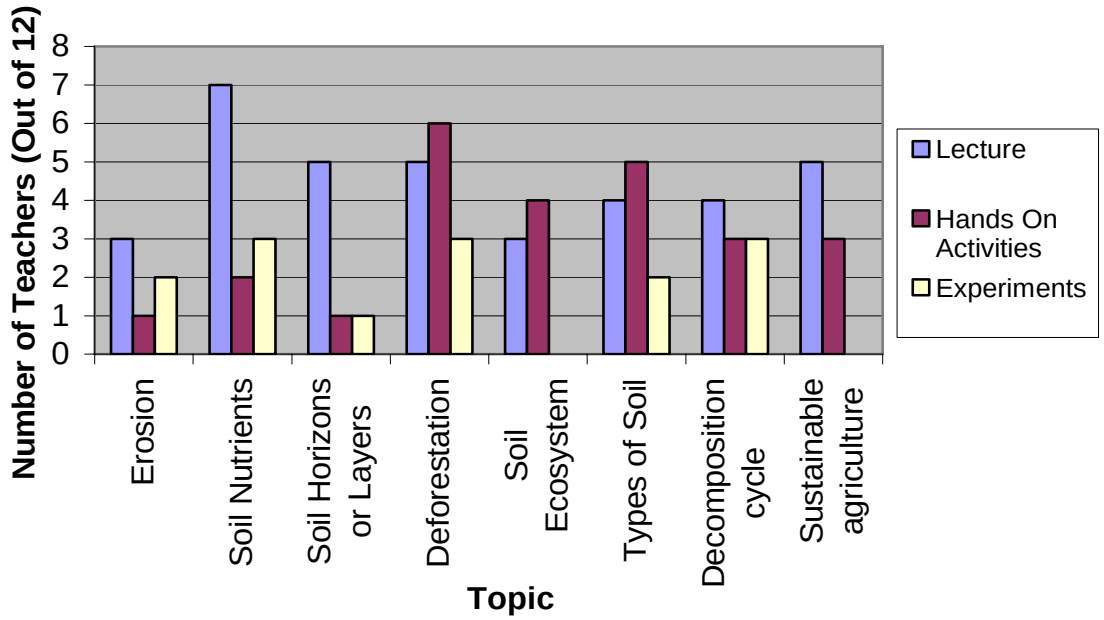

Figure 4.4-2: Methods Used by Suan Phung Teachers to Teach Soil Science Topics

4.5 Hands-on activities and experiments should be used to teach the most important topics in the camp.

Our background research suggested that hands-on activities are an important part of environmental education. Both the IGES report (2002) and IUCN report (2002) revealed that hands-on experience is an essential part of a good environmental education program. We confirmed this information by interviewing students.

The most important source of information for this finding was interviews with local students. Detailed summaries of these interviews can be found in Appendix C:. Three out of the four groups of students we interviewed who had attended previous camps told us that their favorite activity at the camp was one in which they surveyed water quality. The fourth group did not attend the same camp. They told us that their favorite activity was learning practical uses for recycled plastic. For this activity, they had to implement the methods they learned.

Our interviews also revealed that students remembered the material from hands-on activities much better. Most students could tell us some of the indicators of good water quality that they looked for during the camp. In contrast, the students we interviewed remembered significantly less about soil science taught in school lectures. Students who learned about soil science in the week before we interviewed them could not describe the topic in detail. All of the students who had attended the water quality camp four months earlier could describe or name some of the insects they had used as indicators of good water quality.

Interviews with the students showed that students both enjoyed hands-on activities more than lectures, and remembered more from those activities. These findings agreed with what we learned from our background research. We concluded that hands-on activities would best fit what our sponsor wanted in the camp, as described by Dr. Chakkrit: for students to "have fun and get some ideas". Therefore, hands-on activities and experiments should be used to teach the most important topics at the camp.

4.6 Local teachers should be involved with the implementation of the camp.

Our background research suggested that an important part of successful environmental education was community involvement. Section **Error! Reference source not found.** has a more detailed description of what that means. For this camp, we chose to include local teachers as representatives of the community. We had access to them, and they had skills that would help

in the implementation of the camp. This decision was supported by comments from officials at the royal projects office and local teachers. The data we collected from both of these sources revealed that not only was it important to involve local teachers in the camp process, but that they were enthusiastic about being involved in the camp.

Our discussions with Dr. Kitti and Somphop early in our research showed that they were interested in involving local teachers. They both wanted to eventually transfer the load of teaching camp material to teachers in Suan Phung. Somphop's team of educators has a number of programs that they teach, at Suan Phung and elsewhere. They would like these camps to be taken over by local teachers so that they could be run more often, and so Somphop's team could focus on other programs. They had difficulty starting this process because local teachers did not have enough training or confidence to volunteer to take any of this responsibility.

We found similar data in interviews and questionnaires with local teachers. On all of the questionnaires we collected, the teachers expressed an interest in attending the camp, and learning more about the teaching methods used at the camp. Our interviews with them revealed that they were interested and excited to work with us on the new camp program, because it would expose them to new ideas for teaching methods and activities for soil science. They told us that they wanted to bring new activities back to their schools.

4.7 There are activities which are essential pieces of any Thai camp program.

In our final refinement of the camp schedule, we presented a proposed schedule to Khun Suthep and three Chulalongkorn University students. Their input revealed that two traditional Thai camp activities were missing in the proposed program. All of the camp curricula we investigated had opening and closing ceremonies, and a "vow ceremony" on the second evening. We had not included either of these in our preliminary plans for the camp because we considered them to be too formal for our vision of the camp.

Our discussions with Khun Suthep and the Chula students revealed that these were actually very important parts of the previous programs. The main part of the opening and closing ceremonies was an exercise in which each student took their neckerchief (in the opening ceremonies) or their certificate of completion (in the closing ceremonies) from a pedestal beneath a portrait of HRH Princess Maha Chakri Sirindhorn. We were told that this represented

receiving those items from the Princess herself, and that this had a significant importance to the students at the camp.

The Chula students informed us that the "vow ceremony" was a part of every camp they had attended. The importance of this activity had been lost in the translation of the water quality camp curriculum. In the "vow ceremony," each student lights a candle and promises to protect the environment. The exact process of this ceremony is important enough that Khun Suthep told us that an expert would be invited to conduct the activity. Though this ceremony seemed overly formal to us, we learned that it was another exercise which held deep meaning for Thai students.

4.8 Conclusion

In designing the education camp, our research led us to seven major findings. These allowed us to design the program and to create a teacher handbook to guide instructors in implementing the program. Our findings allowed us to tailor these materials to the conditions in Suan Phung, and to implement that camp. Details of that implementation are discussed in Appendix A:. An important part of that implementation was evaluation. Our findings from that process are discussed in the next chapter.

5.0 Findings and Discussion for Evaluation of the Camp Program

During the three day camp we constantly collected data in order to evaluate its performance. We examined data from observations made by all of the staff involved with the camp, pre- and post-tests completed by the students, and ideas and issues that were raised in daily debriefing sessions. We collected data in areas such as: student learning and enthusiasm, confusion on the part of both instructors and students, and difficulties instructors had in presenting the topics.

This evaluation process allowed us to identify aspects of the camp that needed improvement, and others that were successful. One important finding was that some of the evaluation tools used were ineffective. Despite this difficulty, we were still able to collect useful data, and our evaluation of the camp led to six other findings:

- The camp successfully engaged students
- Fun activities were not adequately interspersed with educational activities
- Activity instructions were unclear or confusing
- The experimental activities were too complicated
- The camp did not include enough teambuilding activities for the students
- Teachers were not involved enough in the camp

We used these seven findings to modify the camp materials so that the next implementation of the camp will be better. These modifications were made both during the camp and afterward. Each of the findings will be discussed further in the following sections.

5.1 Some of the evaluation tools used were ineffective

When we designed the evaluation process for the camp, we planned to gather quantitative data on the performance of the camp through student pre- and post-tests, observation sheets. We wanted measurable data that we could back up with comments and our own unstructured observations. Unfortunately, neither of these evaluation methods produced the data we expected. They still gave us usable information, and the addition of daily debriefings to these tools gave us a significant source of data. The difficulties with the tests and observation sheets will be discussed further in the following sections.

5.1.1 Pre- and Post-tests

The student pre- and post-tests were intended to provide us with measurable data on the knowledge gains students made while at the camp. The questions on the test targeted the major topics taught at the camp in order to determine the effectiveness of each of the activities in the program. To measure gains, we planned to administer the same test both at the beginning and end of the camp.

As a result of vague wording and students' difficulties with written communication, the pre-test failed to elicit the intended data. Our original intent of the pre-test was to make all of the questions open-ended to prevent us from leading the students to the correct answers. This plan backfired on us, because the students did not understand what type of information was required for each question. All of the staff of the camp reported that the pre-test was ineffective. The Chulalongkorn team reported that most students did not finish the test. Data collected on the number of students who left each question agrees with these comments. These statistics are summarized in Figure 5.1-1. The percentage of students who left the later questions on the test blank was much higher than that for the earlier questions.

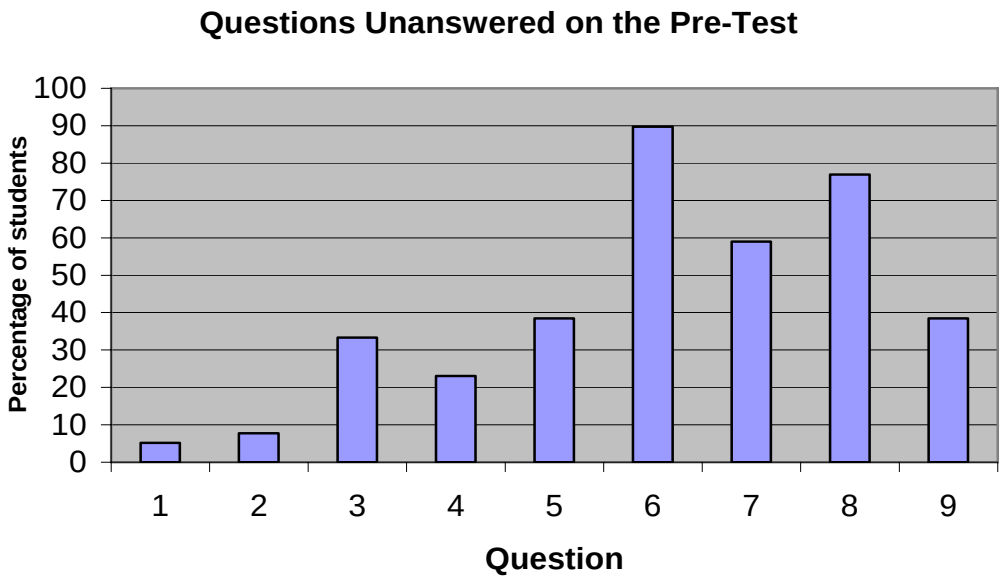

Figure 5.1-1: Unanswered Pre-Test Questions

In the debriefing session on the first evening, the instructors agreed that the questions were too long, open-ended and vague. The Chulalongkorn graduate students informed us that the students required a lot of clarification for each of the questions. These factors were what

prevented some of the students from finishing the test. A number of people recommended that the questions be rewritten as multiple-choice or fill-in-the-blank.

The shortcomings of the pre-test made the data we collected from it unreliable; however, we still wanted to measure the achievement of the students at the conclusion of the camp. Our original plan for the post-test was to have students examine their answers from the pre-test and respond to each. Because 41% of the questions on the pre-test were left blank, this approach would not have been as effective a learning tool as we had hoped. For many students, it also would have been similar to taking the same test again. In addition, the same problems with wording and clarity of the answers would persist, making the results of little use. Our temporary solution for the post-test was to have the questions described verbally, using key words that were used in the topic discussions of the camp.

Describing the questions verbally on the post-test promoted a better testing experience for the students. Only one question was left blank out of all 39 tests, indicating that students had some understanding of what was required for each of the questions. During the debriefing sessions, it was reported that the questions were still too confusing, and the Chulalongkorn team told us that they had to repeat and rephrase some of the questions. The staff at the camp agreed that part of the problem was that questions were not worded the same way as the concepts were in the activity materials. Since the post-test was administered in a different way than the pre-test, it cannot be precisely determined whether improvements in scores were from knowledge gains or improvements in clarity of the questions.

Our analysis of the post-test data suggested that questions that were specific to one activity and that asked for information in the same way it was presented in the activity were successful. On three of the questions (4, 6, and 7), the average score for the post-test was above 2.75 (See Figure 5.1-2). Such a high average score suggests that students understood what was required for those questions, because for free-response questions it is nearly impossible to get the right answer otherwise. Examining these questions for common characteristics shows that they were the most specific questions. Each linked to one specific lesson. The wording for these questions was also the closest to that in the activities. The same terms were used in those questions that were used when the topics they tested were presented. For example, question 6 was, “Please describe or draw the nutrient cycle.” Every student drew the diagram that had been presented in the same way in the lecture for this question.

The worst-scoring question on the test, question 1, had very different characteristics from question 6. Question 1 was, "What three things is soil made of?" The score on this question was particularly low because students confused two activities during the camp. One of the presentations by Rabbit in the Moon told the four things a plant needs to grow. We saw this as one of the typical answers for the first question, which asked for the three things that make up soil. The components of soil were never explicitly listed together in that way. Therefore, it is understandable that students could confuse it with another activity. More detailed data from the pre- and post-tests can be seen in Chapter 5.

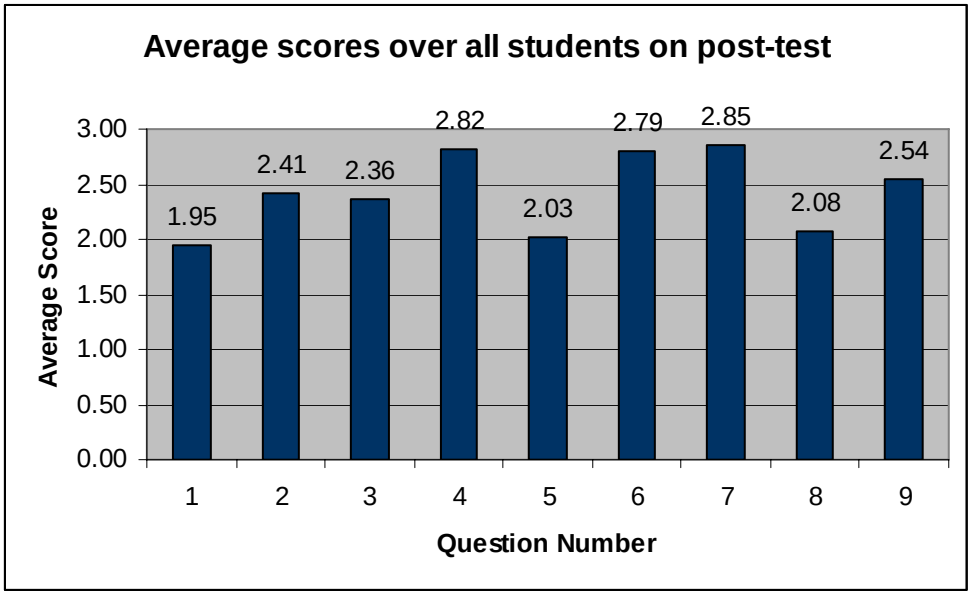

Figure 5.1-2: Average scores for students on post-test

Questions on the pre- and post- tests

1. What three things is soil made of?
2. Name at least 3 characteristics of good soil
3. What characteristics of soil are important to plant growth?
4. Name at least 2 ways humans can help cause erosion
5. List at least 2 examples of poor farming methods
6. Please describe or draw the nutrient cycle
7. Name at least one source of soil nutrients
8. List at least 2 ways to prevent erosion
9. Describe how the park is helping with the forests

5.1.2 Observation Sheets

To measure the interest and excitement of the students, we distributed observation sheets to the Chulalongkorn University students who instructed and supervised students during the camp. Unfortunately, these did not elicit the data we intended. Fewer sheets were completed than we had hoped, and the results varied greatly from observer to observer.

We found that the observation sheets were not organized well enough for reliable data to be collected. The data collected did not demonstrate any trends, perhaps because the sample collected was too small. The observations were not uniformly distributed across the activity times, preventing us from drawing any conclusions from the results. Our observations led us to conclude that these difficulties were largely due to the distraction of the observers. Instruction at the camp took more energy, attention, and people than we had anticipated, and as a result, the instructors were not able to devote much of their time to completing systematic observations.

5.1.3 Conclusion

In practice, the pre- and post-tests were not as effective as we had hoped. Much of the data they gave us was unusable. The data primarily provided information on the effectiveness of the evaluation tools. Fortunately, the daily debriefings with all of the camp staff provided plenty of information and suggestions for improvement. For these reasons, our evaluation of the camp program had to rely much more heavily on the daily debriefings, our personal observations, and comments by staff at the camp.

5.2 The camp successfully engaged students

Based on our evaluation of the Soil Conservation Camp we found that the camp successfully engaged the interest of the students throughout the three days. Comments from staff at the camp, both in debriefings and at other times, consistently emphasized this. We were able to correlate their comments with our own observations.

We frequently heard comments on how much students were enjoying the camp. This was true even on the first day, when students were the most frustrated. Pu told us that immediately after the second activity on the first day, that one student had told her that “she had never been this happy”. We observed that the students were interested in the activities, and that they were engaged and actively participating in learning. On the third day, we learned in the debriefing that

some students found the Soil Conservation Camp to be one of their best experiences and they did not want to go home. Comments such as these were frequently mentioned in the nightly debriefings.

A number of activities demonstrated that students were engaged throughout the entire program. Toey, one of the instructors for the second day activity, asked the students at the second experimental site, to teach her the technique for the soil texture test. A number of students were able to demonstrate the experiment, and tell her what conclusions should be drawn from their results. At the debriefing on the second night, it was reported that though the students had not been exposed to labs or education camps, they were working diligently. Many of the educators that observed the camp commented that the children were happy and enthusiastic.

The best indicator of student involvement, however, were the plays students performed on the second night and the posters and presentations they made on the third morning. These demonstrated an understanding and appreciation for the concepts that had been introduced throughout the camp program. Pu told us that she was very impressed with the plays, that the children had all "adapted the class knowledge very creatively and naturally", even though they were not given a lot of time to prepare them. Our own observations confirmed this comment. The plays and posters demonstrated that the students appreciated the importance of soil and how it connects everything in the environment. They included in their posters and plays ideas that the camp had emphasized. For example, one of the plays performed was "The Princess who was Afraid of Dirt". The students presented in a creative way the importance of the soil to the environment. All of the posters showed farming methods such as terracing and contour cropping, and both the presentations and plays discussed healthy environments and how they were related to good soil.

5.3 Fun activities were not adequately interspersed with educational activities

Through a series of evaluation methods, we determined that fun activities should be spread out better amongst the educational activities during the Soil Conservation Camp. During the first day of the camp, the students performed experiments for about four hours with very limited break time in between. Because the camp started a little late, we had to eliminate an hour block of fun activities in order to finish the educational experiments on time. We noted in our personal observations that students began looking tired and slightly disinterested towards the end

of both activities. Teachers were also having more difficulty at the end of each activity engaging the students in discussion and participation. This indicates that students need experiments to be split up a little better to allow them time to process all the information they just learned.

On the second day, the students had significantly lower energy at the third Soil Scientist site than any other. A debriefing afterwards with the leaders of this site, Milk, Joy, and Khun Suthep, indicated that it was harder to interest the students. Additionally, our personal observations revealed that the students were getting bored; perhaps because it was already their third time doing the same experiment. This contrasted from the reports from the leaders of the fourth and second sites, who said in the debriefing that students were very attentive to the activity. Between the third and fourth activities, the students spent an hour having lunch and relaxing. Our conclusion was that the students were much more responsive following breaks and fun activities. Similarly, during the second and third days, personal observations and comments from the Chula grad students suggested that the students responded much better to experiments after having some time off or a fun activity in between.

5.4 Activity instructions were unclear or confusing

One of the most important things that our implementation of the camp revealed was that the activity instructions in the camp manual were not clear enough for either instructors or students. We identified two materials that required clarification: the instructor handbook, and student worksheets. The problems with clarity in both of these materials are described below.

5.4.1 Instructor handbook

The instructor handbook needed a significant amount of clarification. The staff at the camp repeatedly commented on the clarity of the instructor materials provided. Discussion in the debriefings was primarily devoted to the need to clarify these materials. Our own observations confirmed that the instructions for the activities needed to be improved. Because of the volume of data collected for this finding, the discussion here will focus on the difficulties in one activity.

Our instructions for the second activity, Erosion in Action, in particular caused a lot of confusion. There were a significant number of questions from the grad students about the process. The instructions in the manual were not specific or precise enough for them to lead the activity in the way it was intended. For the descriptions of the process to follow, the teacher handbook was not descriptive enough for them to understand the intent. They asked us things

like how large the “terraces” were supposed to be in one box, and what they were supposed to look like. We had to verbally clarify instructions for all five of the erosion tests.

Our observations revealed that even our verbal instructions did not adequately clarify the activity. Some of the experiments for that activity were still constructed incorrectly. For example, students packed the “bare hillside” box more than any of the others, which skewed the results. The “terraces” were too small in all of the boxes, and for most of the groups, their “contour cropping” box looked more like what we intended for the “terrace” box. Because our instructions were not clear enough, some of the groups got results that were not intended.

The difficulties with this activity were reflected in the comments during the debriefing that evening. Everyone who participated in that debriefing said that all of the steps in the second activity needed to be clarified. The instructions needed diagrams, and precise instructions and measurements for things like the packing process and the size of the terraces.

Though "Erosion in Action” was the best example of unclear instructions in the manual, we had similar comments on other activities as well. For most of the activities, the instructors wanted precise measurements and diagrams so that the experiments could be reproduced exactly. These comments were supported by our observations that verbal and written instructions were not adequate.

5.4.2 Student worksheets

Based on nightly debriefings and personal observations, we found that the directions of the student worksheets were not clear to the students. Our personal observations revealed that students were much slower in completing the worksheets than we had expected, making the first activities significantly longer than planned. Students also had to be encouraged quite often and many things had to be explained to them better. We were told that the questions on the student worksheets had wording problems. It was not clear whether these developed through the translation process or were present in the English materials as well.

Our interviews with the Chula grad students and other staff members identified more specific areas of poor organization in the student worksheets. For example, some activities featured recording information on different pages, which was difficult and confusing for the students. It was suggested that the worksheets would be much more user-friendly if results were compared on the same sheet of paper, especially if data collected were recorded in a table.

Personal observations of students using tables revealed that this was much easier to read and understand for them.

5.5 The experimental activities were too complicated

Our evaluation of the learning material of the camp revealed that the information presented was too complex for this group of students. The material, although important for the students to learn, was not well suited to those who attended. We noticed these difficulties in both the educational activities and the student worksheets. The particular difficulties for both of these are described further below.

5.5.1 Educational Activities

Our evaluation methods found that aspects of all of the activities were too complex for this group of students. On the first evening, the instructors at the debriefing spent over twenty minutes discussing the difficulties students had understanding parts of the activities. One of the things we learned from this discussion was that the students who attended the camp were not as proficient as those we had interviewed on our second trip to the park.

At all three of the debriefings, the group discussed the students' particular difficulty with scientific process and experiments. They did not have much practice with the type of thinking or approach expected from the activities. In particular, the "Just Passing Through" activity's scope was too large for the group of students. They had difficulty reading, understanding and digesting the implications of the experiment. We also learned at the debriefings that the students had difficulty comparing and examining trends between many different experiments. For example, in the "Erosion in Action" activity, students compared five different "hillsides" and examined the effect of erosion on each. The educators that participated in the debriefings agreed that the number of examples should be reduced. They also said that the students would understand the activity better if there were two or three examples, with all of them demonstrating clearly "good" or "bad" practices.

5.5.2 Student Worksheets

The recording work that the activities required of students was also reported to be too complex for the students at the camp. In particular, the worksheets required too much hypothesis work for the students. In the debriefing, we learned that the students felt that many of the

questions in the hypothesis section of "Just Passing Through" were redundant. The questions were too similar and too involved. One idea that the group liked was making the students record a single hypothesis, but discussing with the group the other questions. Similar comments were voiced about the worksheets for other activities as well.

5.6 The camp did not include enough team-building activities

One of the major difficulties early on in the course of the camp was that the students did not work very well in their groups. Since many activities in the camp rely on group collaboration, this is especially important. The division in the groups was noticeable from the first day. Comments from staff emphasized this difficulty throughout the camp. Our observations supported these comments.

Though we do not speak Thai, the division in groups on the first day was noticeable. The students were from two schools. All of the students from one wore blue, and the other school group wore yellow. On the first day, all of the groups were polarized into the blue half of the group and the yellow half. In the debriefings that evening, the staff of the camp informed us that the students required a significant amount of encouragement to work as a group.

We learned from the debriefings that the students at the camp were particularly shy. We continued to hear comments about their shyness throughout the camp from the Chula graduate students, local teachers, and Dr. Siripastr. The group at the debriefings agreed that there were not enough icebreaking activities at the beginning of the camp. Khun Suthep informed us that at other camps, students have come the night before for icebreaking and team-building games.

Our conclusion that the students needed longer to become comfortable with their group members was reinforced by what we observed on the second and third days. During the "soil shake" activity at the end of the second day, we noticed that all of the groups were cooperating better than they had on the first day. By the third day, while making the posters and presentations, students were much more comfortable with each other and staff. During the debriefings, the supervisors for two of the groups told us that the groups showed an impressive level of cooperation. They brainstormed first, then divided their tasks amongst themselves and worked together to complete their posters. Other instructors agreed with these observations during the third debriefing. They were impressed with the incredible level of cooperation and idea exchange between students during this activity.

5.7 Teachers were not involved enough in the camp

During the initial design of the camp, our plan was to directly involve the teachers and have them teach a majority of the camp. This was not possible, because we did not have the opportunity to properly train them for this task. Instead, we decided to have them each supervise a group, and to help guide discussions and clarify ideas for the students. We found that the teachers who attended the camp benefited from the experience, but we felt that they should have been more actively involved in the process.

Before the camp began, the teachers sat down with the Chula grad students to learn about the activities to be completed over the weekend. This allowed them to participate in the instruction of students. We observed the teachers helping the students in almost every activity, by assisting the students or explaining the experiment to them. Director Cheelio related that he and his colleagues were very impressed and interested in the information presented at the camp. They asked for all of the materials from the camp experiments and even took the posters used for the lectures to aid in their teachings. During debriefings, the teachers also had excellent comments and ideas about how to improve the camp and the material presented.

However, we noticed that there were significant periods of time during which the local teachers seemed to have little to do. Were it not for the comments they made, we would have thought they were bored for most of the weekend. Our intention was for them to be actively involved in all the discussions and activities throughout the camp. However, we did not adequately describe their tasks at the camp for them to assume the role we intended.

5.8 Conclusion

The process of evaluating the camp program led us to seven findings. Communication difficulties between both English and Thai, and Thai and Karen, the dominant population of the Suan Phung area, contributed to evaluation and program design problems. This, compounded with insufficient instruction detail on our part posed the greatest barrier to our efforts. Even with these difficulties, through adaptation of the curriculum we were able to conduct a successful camp; however, there is still more work to do on the soil conservation curriculum as well as other park programs in order for the Royal Project Office's goals to be fulfilled.

6.0 Summary

Our findings from the evaluation of the camp have led us to develop recommendations for future camp development and possibilities for future research. The section below outlines ways to improve the Soil Conservation Camp that we developed. The second section below details future research that can be done in conjunction with the Royal Projects Office and Suan Phung Nature Education Park to help these organizations achieve their goals in protecting the environment and spreading awareness of natural conservation.

6.1 Future Recommendations

The Royal Projects Office is seeking to improve environmental and social awareness among the population of the Suan Phung area. The development of the Soil Conservation Camp was an example of this endeavor. Based on our findings from implementing and evaluating this camp, we developed a set of future recommendations:

- Assessment methods
- Teacher involvement
- Continuous improvement of curriculum

These recommendations will be extremely helpful in the success of future Soil Conservation camps and other environmental education camps. Each is explained in more detail in the sections below.

6.1.1 Assessment Methods

Because of our experiences in evaluating the camp program, we recommend that a better assessment method be developed. Our evaluation of the camp included teacher surveys, observation sheets, and a pre/post test for the students. The teacher surveys were replaced with daily debriefings and proved to be very effective. The observation sheets were used for three of the activities but were not systematically implemented. The pre/post test was ineffective because of communication problems. A majority of the students who attended the camp were Karen, and spoke Thai only as their second language. Many had difficulty reading and understanding the tests, causing our results to be less accurate. This test was not an appropriate way to assess the knowledge of the students. Based on the data we gathered, we decided that it was more important

to focus on what aspects of the camp could be improved, instead of determining if the students retained information presented at the camp. Our evaluations focused more on how the camp delivered information, rather than measuring what information was gained by the students.

The communication difficulties we encountered during our evaluation methods made it difficult to draw conclusions on the knowledge gains students made while at the camp. It is important to measure this kind of data in order to ensure the camp is conveying the intended information. Therefore, a better assessment method should be developed. A better evaluation would not rely on written communication and would, therefore, overcome the troubles the students had understanding our tests. An improved evaluation process should also include a means to evaluate the amount of information the students retained after a longer period of time, anywhere from 3 months to half a year.

6.1.2 Teacher Involvement

We recommend that teachers have a greater involvement in future Soil Conservation Camps. In designing the Soil Conservation Camp, we found that involving local teachers would contribute significantly to the long-term success of the program. We originally planned to have local teachers run each experiment, but upon further investigation, determined that we would not have enough time to properly train them to do this. Instead, the Chula grad students lectured and lead each activity, and the teachers observed. Although the teachers were very impressed with the camp curriculum and teaching materials, they did not have a direct role in the execution of the camp.

We have a number of recommendations about how teachers should be included in the camp programs:

- Teachers from every school should be involved. This will allow the camp to impart knowledge to the entire community.
- Teachers should lecture and run the activities. This will encourage them to take more interest in the material covered, and give them a better understanding of the activities if they want to take them back to their schools.
- Teachers from different schools should cooperate in running the camps. Cooperation may encourage the sharing of teaching ideas and materials.

More teacher involvement will eventually lead to more involvement from the rest of the community, as the program becomes independent of the Park and its staff.

6.1.3 Continuous Improvement of Curriculum

Though our implementation and evaluation of the Soil Conservation Camp allowed us to improve the camp curriculum, we recommend that a method be developed to constantly and consistently reassess the progress of the camp. Our experience, which is described in Appendix A:, provides one example of how this might be done. An assessment and improvement process should be part of every camp, even those which have already been improved through such a process.

Our evaluation findings, described in Chapter 5, led us to design and adapt all elements of the camp curriculum. We found that the Suan Phung area was wanting in specific topics relating to soil conservation, prompting us to incorporate education about basic soil, erosion, and sustainable agricultural practices into the curriculum. Our findings also revealed that students respond best to hands-on, cooperative learning for environmental education. In response to this finding, the Soil Conservation Camp contained a series of interactive, group experiments. These findings, along with those pertaining to fun activities for students and essential elements of Thai environmental camps, allowed us to develop a complete camp curriculum.

The changes we made based on our evaluations during and after the camp have produced a final recommendation for the Park to use in the future and can be seen in Appendix A:. However, we made modifications to the curriculum based on only one iteration of the camp. Most likely, more changes will be needed after running the camp a few more times. A reassessment process would involve evaluating how the camp functioned, and making any necessary changes to the curriculum. Ideally, this reassessment would occur after the completion of each Soil Conservation Camp, with changes in effect for the next time it is run. A similar process should also be applied to other environmental education camps.

6.2 Future Research

The Soil Conservation Camp that we developed for our sponsor, the Royal Offices of HRH Princess Maha Chakri Sirindhorn, was designed specifically for the Suan Phung Nature Education Park. Our goals in establishing this camp were based on four main guidelines of the Suan Phung Nature Education Camp as outlined by HRH Princess Maha Chakri Sirindhorn:

1. to conserve and improve the area and to create a place for natural conservation education for local people and general public;
2. to explore, research, and collect all data on physical, biological, and social resources within the area;
3. to apply research studies for local community benefit;
4. to promote the participation of local people in natural conservation.

Any future research done in relation to the Suan Phung Nature Education Park should work to further these goals. We recommend that future research at the Suan Phung Nature Park include:

- Training program for local teachers and staff;
- Partnership between a college and the Park ;
- Teaching packets for local teachers ;
- More camps on other environmental issues;
- One day camp programs;
- Standard program for all local students (have all the students in a certain grade go through camp series instead of a mix of grades);
- Process to design a conservation group for local people;
- Adult environmental education program;
- Community-teacher network (based at the Park to organize environmental education and spread ideas for teaching methods).

These ideas for future research will aid in developing the Suan Phung Nature Education Park to better achieve its established goals, and are briefly outlined below.

Develop a Training Program for Local Teachers and Staff.

Our original intent for the camp was to directly involve local teachers and Park staff in running and teaching the camp, but we were unable to do so. Our main reason for involving the teachers in this camp was to increase community involvement in addressing and solving environmental conservation problems in the Suan Phung area. We decided that although most teachers wanted to get involved in the camp, they were not prepared to teach the lessons presented in our itinerary. We found that of the small group of teachers we surveyed, only a few actually wanted to teach, while the remaining either did not feel comfortable doing so or wanted to observe only.

The inclusion of teachers in a more active role would help spread environmental education throughout the community. Therefore, we recommend the future development of a training program specifically for local teachers and staff. This training program could be similar to teacher workshops held in the United States; it would give the teachers the necessary information and tools to teach about environmental conservation in the classroom or at a Park such as Suan Phung.

The park should seek to establish a partnership with a university.

Although our plan during the initial design phase was for local teachers to instruct each activity, we and the Chula students decided to have them assume this role instead. This worked very well and proved beneficial for everyone involved. We were able to work very closely with the graduate students while developing the camp, something we would not have been able to do with the teachers. This enabled us to explain activities to the graduate students so that they could confidently teach the students about each topic during the camp. During the camp, we also found that the students responded very well to the instruction and guidance of the Chula students. This is most likely attributed to smaller difference in ages between the graduate students and the local students. Although the local students respect the graduate students, they are not parent-like figures similar to their teachers from school. This also allowed the students to experience a slightly different style of instruction. A partnership between a university, such as Chulalongkorn, and Suan Phung Nature Education Park would allow for more camps to be run by providing a constant supply of personnel and would allow camps to change to more innovative techniques.

Create teaching packets for local teachers.

Based on our findings in the design of the camp, we determined that teachers do not educate the students very thoroughly on most environmental problems (see 4.0 Findings & Discussion for Design of the Camp Program). Teacher surveys and interviews showed that soil was not covered very extensively in schools. We found that teachers do not have a lot of background or materials on environmental conservation. These findings, along with the fact that the teachers who attended the camp specifically asked for our materials, led us to determine that teachers could use more in the way of teaching tools for environmental issues. Future research could be done into providing local teachers with lesson plans or ideas about how to teach about environmental conservation. Our findings demonstrated that the majority of teachers use a

lecture style to teach; however, IGES reports that the best teaching tools for students are hands-on activities (1999). Lesson plans for local teachers might include a series of hands-on activities or experiments that can be conducted at their school. Teaching packets can also be linked to each of the camps Suan Phung Nature Education Park is already running. This would allow the teachers to continue the environmental education of the students even after they leave the camps.

Develop More camps on other environmental issues.

The Soil Conservation Camp, along with other camp programs that Suan Phung Nature Education Park has developed, cover only a portion of environmental issues for the area. When deciding on a camp topic, our sponsor gave us some recommendations to choose from, including, but not limited to, biodiversity, wildlife, rain-shadow forest, and soil. Future research can be conducted on designing, or developing a process for designing, another environmental education camp. Khun Sompop expressed an interest in additional camps about insects, animals, and plants in the coming years. Although we found that primary students were the best audience for environmental education camps in the Suan Phung locale, camps on new topics, or improvements to existing camps may be designed for secondary students as well.

Implement a series of one-day camp programs.

Students in local Suan Phung schools learn a limited amount about environmental problems in their region. The camps at Suan Phung Nature Education Park are designed to reinforce their environmental education in school. Our findings from teacher interviews and surveys and student interviews demonstrate that the local teachers do not always have the means to teach extensively about the environment. Considering the important role the environment will play in many of these students' futures, future research could be focused on developing a program between the Park and local schools. This could involve Park staff visiting local schools and teaching students for a day, or one day field trips to the Park office. Field trips, in particular, would be one way to reinforce what the students have already learned in school via lectures. During the field trips, the Park staff could conduct hands-on experiments with the students that might not necessarily be possible at their schools.

Make environmental education camps a standard program for all local students.

The social context of our project involved raising the awareness of the community about the dangers of unsustainable land-use practices. Our research methods revealed that only 45 percent of primary students will continue to secondary school, leading us to find that a majority of the student population will most likely continue the farming practices of their parents. Thus, primary school is the place where the largest population of students, of the future generation, can be reached. The Soil Conservation Camp was designed as a way to educate the students about the importance of soil in sustainable land-use practices. To help ensure that all students experience the environmental education camps, future research should involve developing a standard program for local students. This program may require that all students, from all local schools, attend the environmental education camps during a certain grade. This would ensure that each student passing through primary school would experience the camps during a designated grade.

Begin a process to design a conservation group for local people.

One of the goals of Suan Phung that was integrated into the development of the Soil Conservation Camp is to increase community involvement in natural conservation. Our observations and findings gave little indication of participation by local people in protecting the environment. A process may be developed in the future to design a conservation organization for the local people. An organization such as this would involve the community and increase their awareness of preventable environmental threats.

Create adult environmental education programs.

The Soil Conservation Camp we designed focused on primary school students based on our findings from interviews and surveys. Primary school age students are the easiest to reach and are easy to teach. We found that these students will most likely continue the farming practices of their parents; by encouraging these students to practice a more sustainable form of agriculture, the future of the environment of Suan Phung will be healthier. These students are the future of the Suan Phung area, and results from the camp will not produce changes for a few more years. In the meantime, there are still many local people who use unsustainable land-use practices. This problem could be alleviated by the development of an environmental education program for adults. This program could work closely with the King and Queen's demonstration

farm, located in Suan Phung, to encourage local people to use more environmental-friendly practices, and to consider their future and that of the environment.

Develop a Community-teacher network.

The environmental education camps at Suan Phung have begun the process of improving the local community's awareness of environmental issues. To continue this process, the Park should promote more community involvement in natural conservation, and provide a source of environmental conservation education. A network between local people, universities, Suan Phung, and other national Parks could do this by encouraging the sharing of ideas. A network would raise awareness of environmental problems, help to better organize environmental education at the Park and spread ideas for teaching methods. Teachers could share and discuss teaching materials for environmental education, while universities could conduct research to benefit the local communities. Information could also be shared between Parks to find more efficient ways for them to operate.

6.3 Conclusion

Economic development in Thailand strains the country's natural resources. As Thailand's people try to raise their financial standing, the long-term impacts of their actions become of lesser importance. This often results in environmental degradation.

Suan Phung is an area with unique biodiversity which has been harmed through the region's history of harmful development. Suan Phung Nature Education Park has been established to protect the area's diversity and to reverse the trend of harmful development. One of its primary strategies in this effort is to educate local people about the impacts their actions can have on the environment.

Research has shown that children are an effective target for this kind of education, because they are the future leaders of their communities and because they are often more open to change than adults. Suan Phung's programs include a series of environmental camps for local children that seek to raise their awareness of human impacts on the environment, and to teach them the importance of environmental conservation.

Our development of a new camp for this program considered the conditions in the region. Through interviews with Royal Projects Office and Park staff and our personal observations, we were able to identify soil conservation as a particular concern in Suan Phung. Further

discussions with Park staff, local teachers, and students allowed us to create a pilot curriculum for a soil science camp. Our study of Suan Phung allowed us to tailor this program to the needs and concerns of the area, the knowledge of the local students, and the cultural expectations for such a program.

We implemented and evaluated this trial version of the camp, and evaluated it in order to refine the curriculum and materials we had produced. Some of the evaluation tools we used did not produce the data we hoped to obtain. The process, though, still taught us about the needs of an environmental education program for the children in the region, and the specific challenges in teaching them. We learned that the education level of children in the region varies greatly between schools, and that the variety of ethnic backgrounds in children makes communication a challenge. Information such as this allowed us to identify many areas for improvement of the trial curriculum.

The entire development, implementation, and evaluation process revealed specific needs for environmental education in the Suan Phung area. We were able to identify opportunities for improvement to the soil conservation camp beyond the scope of this project. In addition, we identified many ideas for new programs that could further the goal of Suan Phung Nature Education Park to promote environmental conservation through education of the local people.

We hope that the camp we developed will become a permanent part of the curriculum at Suan Phung Nature Education Park, and that our preliminary efforts to involve local teachers will be the beginning of a larger effort to involve the entire local community in the Park's conservation work. The interest, enthusiasm, and dedication of the students we met in the implementation of the soil camp are an encouraging sign of the bright future of the Park's work. By continuing their efforts to educate the local community about the importance of caring for the environment, we hope that Suan Phung Nature Education Park will become the center of a community that is a part of the natural environment; a community that uses the area's abundant natural resources for their livelihood without upsetting its delicate balance.

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Appendices

Appendix A: Camp Implementation

The weekend of February 17th – 19th, 2006, the camp program we designed was implemented. Thirty-nine students from two local schools participated in the camp. The staff of the camp included eight Chulalongkorn graduate students, Dr. Siripastr, staff from the Royal Projects Office, Park staff and other community organizations. The camp ran into a few problems which were quickly addressed and will be discussed below. The overall camp was a success and learning opportunity for all involved. The following sections detail the ups and downs experienced throughout the camp.

A-1 Organization of Camp

A great deal of work went into preparations for the camp. We designed the activities, instructional materials, and structure of the camp, but we were not able to directly instruct the students. We, therefore, relied on the help of many people and organizations for the implementation of the camp, including Chulalongkorn University, The Royal Projects Office of HRH Maha Chakri Sirindhorn, Rabbit in the Moon, Suan Phung Nature Education Park, and teachers from local schools.

A-1.1 Chulalongkorn University

Our liaison, Dr. Siripastr, a chemistry professor at Chulalongkorn University and her graduate students were instrumental in the execution of the camp. The Chula graduate students provided numerous translations of camp material for us in the weeks leading up to the camp. It was found during initial interviews with local students in Suan Phung that they spoke little to no English. All students spoke Thai. Though for some it is not their native language, they are required to learn and use it in school. For these reasons, it was very important to write clear and specific instructions on the student worksheets, and to have these worksheets translated into Thai. The analysis of the teaching surveys we gave out during our second trip to Suan Phung, along with input from the Chula students, led us to decide that it would be best if teachers only observed during the camp. It was agreed that the Chula students would teach all activities. Having them translate all instructor materials into Thai gave them the opportunity to read over

all activities and gain a better understanding before the camp. They were then able to describe activities in depth to local teachers and adequately instruct students at the camp.

Dr. Siripastr and the graduate students, specifically Naam, Apple, and Toey, provided great insight into the organization of the camp. Through their experience of similar Thai camps, they were also able to provide insightful input into the organization the schedule of events for the camp. Based on our findings in relation to activities from other Thai camps, we decided that fun activities had to be mixed in with educational activities during the camp. Because of our limited experience with Thai students and Thai camp programs, we asked the graduate students to develop fun activities for the students. There are certain activities that must always be included in Thai camps, which we asked the graduate students to help plan for and schedule in conjunction with the Park's staff.

All of the experiments that were performed during the camp had to be prepared, organized and ready to go before we left for Suan Phung. Dr. Siripastr retrieved all of the materials we requested for the camp, the budget for which was covered by Chulalongkorn University. Under the direction of Naam, the Chula graduate students paired up and each pair took responsibility for an activity. Each pair met with us to assist in preparing and separating materials for their respective activity.

Each experiment or activity required a small lecture or explanation at its beginning. Each pair taught took responsibility for this part of their activity, as well. During the experiments and activities, the Chula graduate students who weren't in charge split themselves up amongst the groups to assist the students. The graduate students were able to explain the experiments well and answer any questions. Working closely with the students allowed the graduate students to give us great feedback about what activities did and did not work, how much the students understood, and how we might improve the program for the future. The graduate students also led the students in some of the games and fun activities. Because the entire camp was run in Thai and by Thais, the graduate students often translated for us what was happening or what someone was saying.

A-1.2 Royal Projects Office

Our sponsor, the Royal Projects Office of HRH Princess Maha Chakri Sirindhorn, was another great help in running the camp. They provided us with materials left over from the

previous camp and a van to transport the students to and from the camp. Khun Somphop and his assistant Kai helped out during the camp, providing further instructions for the students and answering any questions they had. Kai acted as a "big sister" for one of the groups. She stayed with that group throughout the camp and helped them to understand difficult concepts and complete activities. Khun Somphop was a big hit with the students, traveling between groups and offering his help as it was needed. Both provided a lot of useful input at nightly debriefings about how to improve the next day's activities and feedback for future recommendations.

A-1.3 Rabbit in the Moon

Rabbit in the Moon is a conservation organization in Thailand that teaches children about the environment through the arts. During our first interview with Khun Den and Khun Phai of Rabbit in the Moon, they offered to help out with the camp and compose a song about soil for it. Khun Den and Khun Phai, along with other members of Rabbit in the Moon, attended the camp and led the students in icebreakers, fun games, and songs. These were instrumental in getting the kids excited, comfortable and interested about the camp. They performed a few skits and general comic relief to help students relax and unwind after an intense day of learning. They mixed into these fun activities some lessons about the environment. The Vice President of Rabbit in the Moon, Vichean Jedsadakarn, also attended the camp for the first two days.. He helped the students with the activities and experiments they were doing and provided us with extremely helpful feedback about the camp and future recommendations.

A-1.4 Suan Phung Nature Education Park

The Suan Phung Nature Education Park provided us with many things essential to the implementation of the camp. The Park provided the facilities for the activities, accommodations and food for the students. Members of the Park staff served as "big brothers", assisting the students in the experiments. Khun Suthep, the Park manager, retrieved and prepped some of the materials we needed for the Park. During the camp, he assisted with each experiment, helping the students to understand the new concepts they had learned. Khun Suthep also taught at one of the survey sites on Saturday and organized the activities that night. He organized the Park staff, which provided more general help with the students and served as guides around the Park.

A-1.5 Local Teachers

Local teachers were interviewed on our second trip and based on these findings, it was decided that they would not teach at the camp as originally planned. Teachers were still invited to attend the camp because they could learn from the teaching methods used to educate the students. We met with the teachers on Thursday, the day before the camp started, to explain the activities for the weekend. Many of the teachers became very involved during the camp, assisting the students with the experiments and explaining more difficult concepts to them. The teachers also provided useful feedback about the progression of the camp and future recommendations and improvements.

A-2 Day One

During the first day of the Soil Conservation Camp the students did preliminary introduction activities, two educational activities, and ended the day with fun games at night. Thirty-nine students came from two schools, twenty from School A and nineteen from School B. The students arrived a little late, causing the program to run about a half hour behind schedule. The morning began with icebreakers, run by Rabbit in the Moon and the Chula graduate students, and an activity we designed to separate them into four groups. An opening ceremony followed, during which the students received their handkerchiefs. The students received workbooks and took a pre-test.

A-2.1 Pre-Test

The pre-test was the first lesson for us in how understanding can be lost through translations. The test we designed was a failure. The questions were open-ended, and worded to allow students to write down any thoughts they had on a certain topic. However, this confused students. This was partly due to the format; we used essay questions instead of multiple choice or fill in the blanks which are more age appropriate. The major impediment on our test, though, was with errors in translation. The wording of the questions may have been translated different than our intent, but what we didn't account for was that our audience would not be native Thai. Children in Suan Phung come from Myanmar or are Karen, and therefore, speak a different dialect of Thai. The pre-test revealed the difficulties they have with reading Thai language. For

these reasons, many questions remained unanswered on the tests, and students were a little discouraged.

Following the pre-test was an introduction lecture on basic soil science, given by Dr. Siripastr, to ensure all students had the required knowledge to complete the camp activities. Some topics touched upon were soil layers, cycle, and characteristics. This lecture was cut short to try and make up time lost from students arriving late. This resulted in some topics being rushed through. Dr. Siripastr also ran into problems trying to discuss topics with the students. She repeatedly found that they had trouble understanding her by their lack of response to questions. Throughout the day we were spontaneously asked to give short, five minute, English lessons to the students between activities. These generally included teaching the students simple English terms such as animals, colors, and simple songs.

A-2.2 Activity 1: Just Passing Through

The first experiment the students did was called "Just Passing Through." This activity demonstrated how different soils filter nutrients or pollutants out of water. The experiment examined the filtering differences specifically between sand and an organic-rich soil. This was demonstrated with colored water (The full activity is described in Appendix A:). The objective of this experiment was to develop students' abilities to identify physical changes that occur in water as it passes through soil. We chose to include this experiment based on our findings, which indicated that students did not have a solid foundation in basic soil science or soil nutrients. It also helped to demonstrate the importance of good soil. Unfortunately, this activity ran about thirty minutes longer than originally anticipated, further delaying the following activities. Instructors had to ask some clarifying questions to understand how to properly conduct the experiment. The actual time for the experiment to be run was also underestimated.

Students also displayed frustration throughout this activity. In addition to the knowledge based objectives of camp activities we also had process objectives. All activities at the camp tried to teach students the scientific process, through worksheets that guided students through making hypotheses, conducting the experiment and finally comparing results. These steps were very difficult for students to comprehend giving their limited background. Many instructors commented that the wording and length of the questions were too advanced for this age group. They said that the students required lots of prompting and guidance to fill out the work sheets.

As a result of the difficulty, many students lost interest during the hypothesis procedure, although it was reinstated once the experiment was started.

A-2.3 Activity 2: Erosion in Action

The second and final activity on the first day was called "Erosion in Action." This experiment involved students making miniature hillsides and running water down them to study the factors that affect erosion. It demonstrated how different farming practices either prevent or promote erosion (a full description of the activity can be seen in Appendix A:). The objective of this activity was to develop the students' appreciation for some of the causes of erosion through hands-on learning. Our findings had concluded that erosion was a serious environmental problem in the Suan Phung area, so we chose to include this experiment to highlight erosion as an important soil topic.

A few changes were made to this activity from its original format, due to some problems we had with the first activity. Because students were taking a considerable amount of time to fill out the student worksheets during the previous activity, we asked that only one student fill out the information for the entire group during the Erosion in Action activity. In the original instructions, the five different models were tested at the same time to highlight the differences in time for water to run off. We decided that each model should be run separately to allow the students more time to process all the information obtained as a result of the test. The students insisted on recording their observations for themselves, but they enjoyed the activity, especially making the models.

After finishing the last activity and dinner, the students had a three hour block of fun activities before bed. These activities were not related to the work the students did during the day, in order to give them a break and relax. The night included games, songs and dances taught by the Chula students and Rabbit in the Moon. Rabbit in the Moon performed a short, humorous performance about an angel giving seeds to be sown in the earth. This skit reinforced important environmental issues by describing what a plant or tree requires to grow. The evening activities were a great way for everyone to relax after a long day of learning.

A-3 Day Two

On the second day of the Soil Conservation Camp, the students rotated through a series of sites and conducted experiments at each one in an activity we named "Soil Scientists." Prior to

this activity, all students were giving a short talk about the experiments they would do and the investigations they would make.

A-3.1 Activity 3: Soil Scientists

This activity is based on a walking trial around the camp that we helped design. On the circuit there were four sites, stationed by Chula graduate students and a Park staff. The four groups of students were condensed into two groups, and led by Suwat and Milk through the four different sites. Groups 1 and 2 began first, while groups 3 and 4 learned a soil song that Rabbit in the Moon composed specially for the camp. This allowed groups 1 and 2 to complete their experiments at the first site and move onto the second one before groups 3 and 4 began the first site.

At each site, the students received a quick lecture about the soil in the area, some history, and a few environmental concepts. After this, they conducted an experiment and took a soil sample. The first site, or "Garden Site", contained good, healthy soil, in which many plants could grow; the soil was loamy and contained a lot of humus. This was used as an example to compare to the soil at the other three sites.

The "Charcoal Pit" was visited second, and, like the title, contained a charcoal pit. The students were given a brief overview of how burning charcoal and poor farming techniques in this area had affected the soil, along with a description of how the environment recovers from that type of damage. The soil here was dark and poor as a result the process of used to produce charcoal. The site was close to a noticeable change in forest type from low scrub to bamboo. This, along with the limited flora on the charcoal pit itself, demonstrated to the students the steps that a forest goes through to replenish the soil.

Next, the students visited a site previously used for mining. Here, a history of the soil in the area was given, along with how mining creates poor soil. After lunch at a nearby waterfall, along with some down time for the students to relax, the students visited the Big Tree Site. Here, the students learned about how the forest had reclaimed and re-nourished the once poor soil. The soil beneath the big tree was markedly better than soil less than twenty feet away. This demonstrated the effect that mature trees can have on the soil.

Two experiments were used in this activity for each site. The first was the "Soil Texture Test", and the second, the "Soil Shake Test" was conducted off-site, but required a soil sample.

For the “Soil Texture Test”, students took a small amount of soil, added water to it, and used a flow chart describing the testing procedure, to determine the composition of the soil (the full activity is described in Appendix A:). The objective of this test was to enhance the students’ ability to determine soil composition based on physical observations.

At each site, each group of 20 students took two soil samples to bring back to the camp with them for further analysis. Upon their return to the camp, students used these soil samples to conduct the “Soil Shake Test.” The jars containing the samples were filled with water, shook for 30 seconds, and let sit for about an hour (the full description of the activity can be found in Appendix A:). The objective of this activity was to help students to visualize the quantities of each soil component in their soil sample. This experiment allows them to see and measure the different components of soil, confirming their findings from the soil texture test and exercising their scientific examination skills.

The original intent of this rotation of activities was to give students the feeling that they were soil scientists conducting a series of different experiments to ensure the correct results for each site. Although we kept this idea, the experiences of the first day prompted us to eliminate some elements of the activity. Originally, two additional lectures were supposed to be conducted along the trail, and a second experiment included in addition to the Soil Texture and Soil Shake Tests. Two of the testing sites were also supposed to require two soil samples to be collected. The additional lectures were not to be accompanied by any experiments or tests, but were to teach the students more about soil and erosion. These lectures along with the additional samples and experiment were eliminated from the rotation, because the students were having trouble with the amount of information they received the first day. It was decided that 6 lectures and 4 testing sites with a total of 6 soil samples and 12 experiments would be very stressful for the students. In addition, each group was only asked to have one student record the information, although most students chose to take their own notes anyway.

Our observations and the comments during the second evening’s debriefing session revealed that students enjoyed this activity and gained a lot of information from it. The changes we made helped to keep the focus on the important concepts. As it was, students at the third site were more distracted and should signs of fatigue and boredom. After the break at the waterfall following the third activity students were rejuvenated and the fourth site was very successful. It can be assumed that if the activity were longer that these signs could have turned into bigger

attention problems. At the end of this activity students were allowed free time to prepare group skits and relax.

A-3.2 Campfire and Vow Ceremony

The second night had a block of fun activities, along with activities that were conservation related. Students were asked to work on and perform a skit on any topic from the camp around the campfire on Saturday night. The skits demonstrated the breadth of knowledge the students had obtained about soil from the camp. Through the skits the students demonstrated that they had gained a lot of information through the past couple of days. One group even pretended to run through the Soil Scientist activity. The exact concepts that students included in their skits could not be determined because Chula students had a difficult time understanding their dialect. After the skits was a time for local community members, such as Aacaan Cheelio, Khun Suthep, and members of the nearby National Park to give speeches. Rabbit in the Moon added their touch to the night by singing songs and playing games with the students, along with performing a mime show.

The night concluded with a very heart-felt activity. Rabbit in the Moon led the camp in a song during which different individuals were called on to have an "open heart" and express their feelings and gratitude about the camp. This was closely followed by the candle lighting ceremony, a Thai camp tradition, during which the students promised to protect the environment. Finally, to wrap up the night, we taught the students, teachers, Park staff, Rabbit in the Moon, and graduate students how to roast marshmallows and make s'mores.

A-4 Day Three

The third day was relatively short, containing only one activity. A short lecture introducing the activity was given, building on the previous Erosion in Action Activity. This lecture was originally designed to introduce sustainable agricultural practices to the students, but it was decided that more information in such a short period of time, might be too much for the students. Following the activity was a conclusion lecture, post-test and then closing ceremony.

A-4.1 Activity 4: Soil Conservation Poster

The activity for the last day was originally titled Sustainable Agriculture (as seen in the proposed trial camp schedule in Appendix E:), but was adapted to have the students create

posters in their groups containing all of the information they had learned over the past two days. Students had struggled with some of the material that had been presented. For this reason summarizing the material presented previously seemed more appropriate than presenting new material.

The objective of this activity was to allow students to use their imagination and demonstrate what they had learned during the camp. After changing the subject content of the experiment, we still thought this activity was worthwhile because it would reinforce what the students had learned during the camp. It also provided us with another way to see how much information they had absorbed.

A-4.2 Conclusion Lecture and Post-Test

Dr. Siripastr gave a final review lecture of all the information that had been covered to prepare students for the post-test. The trouble we had through out the weekend with verbal and written communication to the students made us concerned that important topics were missed. This lecture used many visuals in an effort to overcome communication difficulties. The structure of the lecture relied on students responding to questions, similar to those on the pre- and post-test. Student participation was noticeably improved from the first lecture. The post-test was given immediately afterward.

The post-test was administered by asking verbal questions and having students write their answers. This was not the original plan, and we felt that it might skew the validity of the results; however, the students had so much difficulty in the pre-test that these were compromised as well. We wanted to learn what the students knew at the end of the program, even if we could not establish the camp as the source of that information. Verbally asking the questions helped overcome the students' difficulties with written communication, helped clarify some of the questions, and helped fix some of the wording issues that had been identified in the pre-test. Student post-test results dramatically improved from the pre-test. There were still a couple instances of students misunderstanding what was being asked.

Following this, there was a short closing ceremony, during which Dr. Siripastr and Khun Sompop gave short speeches and the students received their Camp Certificates. After the closing ceremony, the whole camp participated in planting a tree, followed by camp photos and the students returning home.

A-5 Conclusion

The camp started out rough but with modifications it was a success on many levels. The students learned important information, continued to develop an interest in the environment and—most importantly—had fun. Unfortunately, the difficulties we had in running the camp made much of our evaluation data from observations, evaluations and tests unsuitable for extremely specific evaluation of all parts of the camp program. The problems encountered with the assessment tools are discussed further in section 5.1. The information we collected still allowed us to modify the camp design to address many of the major issues that this trial run of the program faced. Through this implementation of the camp and evaluation we were able to make many recommendations for the camp, the Park and future research projects.

Appendix B: Itineraries for Research Trips to Suan Phung

Date	Time	Activity
Tuesday January 17, 2006	7:30 AM – 10:00 AM	Travel from Bangkok to Suan Phung
	10:00 AM – 12:00 PM	Tour Visitor's center, Vocational training area
	12:00 PM – 1:00 PM	Lunch
	1:00 PM – 6:00 PM	Tour Park with Dr. Chakkrit
	2:30 PM – 3:15 PM	Visit Tako Pittong school
	4:00 PM – 5:00 PM	Visit Bow Wee school (BPP)
	5:00 PM – 5:30 PM	Visit Tin Mine
Wednesday January 18, 2006	8:00 AM – 11:30 AM	Tour Walking path with Dr. Chakkrit
	11:30 AM – 12:30 PM	Lunch
	1:00 PM – 2:00 PM	Visit Takola school
Thursday January 19, 2006	9:00 AM – 11:00 AM	Visit Simlai Siam school

Itinerary for first trip to Suan Phung

Date	Time	Activity
Friday February 3, 2006	1:30 PM – 6:00 PM	Travel from Bangkok to Suan Phung
Saturday February 4, 2006	8:30 AM – 12:00 PM	Visit Ban Huay Phaak School
	12:00 PM – 1:00 PM	Lunch
	1:30 PM – 3:00 PM	Discussion with Chula Students (Naam, Apple and Toey) about specific plans for the camp: schedule & activities.
	3:00 PM – 4:30 PM	Walked the path near the Park office with Khun Joe, examining soil in multiple places
Sunday February 5, 2006	9:30 AM – 10:30 AM	Presenting the proposed schedule to Khun Suthep & getting feedback.
	10:30 AM – 11:00 AM	Examining equipment from previous camp for possible uses in the soil quality camp
	12:00 PM	Naam, Apple, and Toey depart
	12:00 PM – 1:00 PM	Lunch
	1:00 PM	Pu, a PhD student from Chula, arrives
Monday February 6, 2006	9:00 AM – 11:00 AM	Meeting with Local Teachers
	11:00 AM – 12:00 PM	Lunch with Local Teachers
	12:30 PM – 4:00 PM	Visit interesting soil sites near Park office with Khun Suthep & Khun Ghii
	12:30 PM – 4:00 PM	Test some of the planed activities for the camp
	7:00 PM – 10:00 PM	Test more activities, discuss options for 2nd day of camp
Tuesday February 7, 2006	8:00 AM - 8:30 AM	Delivered questionnaires to Ban Huay Phaak School
	8:30 AM – 10:00 AM	Visited Tako Pittong school, talked to teachers
	10:00 AM – 10:30 AM	Visited Demonstration Farm
	10:30 AM – 11:30 AM	Visited Suan Phung Town Offices
	11:30 AM – 12:30 PM	Return to Ban Huay Phaak School , collect questionnaires, small interviews
	8:00 AM – 11:30 AM	Walk the path that will be used for the 2nd day of the camp, detailed examinations of sites along that path
	12:30 PM – 1:30 PM	Lunch
	1:30 PM – 2:30 PM	Discussion with Khun Suthep about new ideas for 2nd day of camp
	2:30 PM	Depart Suan Phung

Itinerary for second trip to Suan Phung

For times when activities overlap, the group split into two groups of two to complete everything that needed to be done. This occurred two times: on Monday, February 6 from 12:30 PM – 4:00 PM, and on Tuesday, February 6 from 8:00 AM – 12:30 PM.

Appendix C: Student Interview Summaries

Bow Wee School

[Sponsored by the Princess]
Teacher: Pook
- The kids interviewed attended the environmental camp

Favorite thing about the camp:

- Singing songs about the environment and soil
- Recycling
- Learning to use plastic for different things and selling (can learn about implementation/actual selling)

What they learned from the camp:

- Unity – working together and conserving the environment; told family what they learned
- How to manage garbage
- Drugs
- Protecting trees and how it [deforestation] negatively affects the soil
- Garbage management/composting

Favorite Game:

- Game to separate garbage: pictures of the garbage, and students have to match trash to the pictures and separate it

What they would like for learning techniques:

- Lectures

The kids here play soccer and volleyball

BBP School – Tako Pittong

- The kids interviewed attended the water conservation camp
- Located in tin mining area

Favorite thing about the camp:

- Surveying the water and the insects and animals in it
  Favorite Game at the camp:
- Singing a song and dancing
- Divide water into good water a bad water: wear hats to distinguish – "pollutant" people are chemicals and mix with the water [tag game]

What they learned from the camp:

- Kind of insects in good water – an indicator of water quality
  Favorite kind of teaching method:
- Games about topic
- English and Thai games to help learn English words
  - They told their families about what they learned from the camp

Games and activities at school:

- Musical chairs
- Looms/weaving (1 day to make a rug)
- Trakow, volleyball, basketball
  Things different in camp than school (liked new activities and games):
- Balloon game: balloons attached to students' feet and they try to pop other people's balloons
- Tug of war
- Eating competition
- Coins in powder: use mouth to get it
- Draw, color, write skits
- No games they didn't like

Takola school

- 412 students
- sang when you're happy and you know it in Thai
- students attended water conservation program

What they liked about camp:

- investigating animals and insects
- using magnifying glass

Favorite game at the camp:

- learning about animals and insect by acting like them
  What they learned from the camp:
- to protect the environment, trees and animals
- to identify water quality by using insects
- how to identify the forest: dry, green indicates how much water [in the ground]
- liked lecture outside activity
- Surveying, etc.

Favorite games in school:

- singing and action songs
- darts

- count and clap on 3s and 7s – go around the circle
- musical chairs
- balloon game
- insect pictures on paper and correlate what names go with which – helps students remember insect
- bingo-ish game

What they would like to study:

- HIV/AIDs
- Surveys, field trips, and investigations
- A lot of insects in water that you can't see

What they want to be when they grow up: nurse, army officer, doctor, policeman

Favorite foods: apples, grapes, papaya salad with fermented fish, banana, grilled chicken

-Told their families about what they learned

Simlai Siam school

- Water Rangers
- 439 students from ages 4 to 12

Favorite thing at camp:

- Surveying water quality
- First physically survey water than use box with different equipment to look at water
- Visual aids and flow charts to create idea behind water cycles
- Camp fire
- Passing candle flame around the circle to teach about the community and the environment
- Idea about cooperative work to achieve goals

What they learned at the camp:

- How to save water
- Difference of animals in the water
- How to test water quality
- What determines good and bad water quality
- How to use energy and conserve it
- How to work as a community to conserve water quality
- How to live together [with the environment]
- Where water comes from

What they like to learn:

- Would like more than 3 days
- More activities
- Survey different water sources
- Survey at different times – there are different species in the water during the day than at night
- Water quality is good if people take care of the water
- Some places might have damaged water
- Want more students in training
- Would like to try another village for surveying

Favorite Game at the camp:

- Match animal with the name – competition: learn very fast and later see if they can remember; played in teams
- Enjoyed meeting kids from other schools

What they want to be when they grow up: forester, farmer, scientist, musician, environmental protector, working with an organization to protect the environment, doctor, ecotourism protector

Favorite Food: fruit, apples, fried morning glory, vegetables from forest (they have a special taste that is different), fried pork (ribs?) with herb rice; saltwater fish, fried rice, vegetables

Favorite Subject: art, Thai, sports, math, science, social (studies) – learn about life and community

Subject they like least: music, English, Thai music, math, music, art, science, music

- play volleyball, futbol, trakow, bingo
- futbol team competes with other school
- girls can play volleyball, trakow, table tennis, track against other schools
- they play a similar game to capture the flag, but without the flag

Ban Huay Phaak School

-Second Trip
-Translated by Apple and Toey

1. **Have you learned about soil in school?**
   Yes, in fourth grade, but they forgot

2. **What do you know about soil layers?**
   They know the function of soil types. They know clay, sand, silt are the 3 main types of soil. They know about the way soil occurs.
3. **What is erosion?**
   They know a little bit, because they learned about it just yesterday (February 3, 2006).
4. **Do you know good farming practices that prevent erosion?**
   Not really, but some children know. Plants can be used to cover soil and what types of plants can be used for this. They do not know how the plant functions to protect soil loss.
5. **Did you learn about nutrients in the soil?**
   They do not know. They know that fertilizer helps the plants to grow, but not how.
6. **Do you know how nutrients help plants grow?**
   Do not know about pH or nitrogen.
7. **Do you know how nutrients get into the soil?**
   They know that good soil has nutrients and they have done observations to determine if soil is good. Good soil has more plants than bad soil.
8. **What animals are in the soil?**
   Earthworms, ants and insects live in the soil. They have dug up earthworms to go fishing with. Earthworms are not in clay, but are in silt.
9. **What role does soil play in the water cycle?**
   They know the water cycle, but not about the role of soil in it.
10. **What is your favorite subject?**
    They do not like studying. Math, science, and Thai music are a few favorites.

- In fifth grade they are in charge of feeding the fish in the pond. They catch the fish and sell it and the money goes to the school.
- The school teaches them to plant small plants: dig soil and put in a small plant or perennial.

Appendix D: Teacher Questionnaires

Welcome and thank you for joining us today. We are students from Worcester Polytechnic Institute in America. We are working with The Office of HRH Princess Maha Chakri Sirindhorn Projects under the guidance of Chulalonghorn University to develop an environmental education camp for Suan Phung Nature Education Park. The camp will focus on environmental issues related primarily to soil. For this camp to be successful we need your help. We need information about the environmental topics that your students are being taught in school. This information will allow us to design a camp that builds on and reinforces what they are learning in school. You are experts on what your students know, so we need your input and advice.

We would greatly appreciate your help in running this camp. This camp will compliment the previous environmental camps that have been conducted in Suan Phung. It is one step in the process to develop a series of environmental camps for Suan Phung that encourages students to be conscience of natural resource conservation. We are looking for instructors to give lecture and conduct activities during the camp in February. Your connections with the students and your experience as educators would make your participation a great addition to this program.

We have some activities planned for today that are intended to aid us in the development of the camp and to provide you with information about it.

- First we will ask you fill out a survey that will help us in the implementation of the camp. The survey is intended to provide us with information about what your students know about soil.
- We will do an activity to show you an example of the types of activities we will run at the camp.
- We will also give you a sample of the teaching materials an instructor at our camp would receive to run that program.
- We will provide you with some additional information about camp activities**.**
- We are looking for teachers to help at the camp from February 17 through 19. Attached is a form where you can tell us how you might be able to help. We would appreciate your participation in this program and think that it will be a good learning experience for all those involved**.**

Thank you for your time.
Matthew Finch
Paul Freitas
Katie Hall
Koren Roach

สวัสดีและขอต้อนรับทุก ๆ ท่านที่สละเวลามาประชุมกับพวกเราวันนี้
ก่อนอื่นพวกเราขอแนะนำตัวเองโดยสังเขป พวกเราเป็นคณะนิสิตชั้นปีที่ 3
จากมหาวิทยาลัยวูสเตอร์ โพลีเทคนิค อินสทิทูท ประเทศสหรัฐอเมริกา
เรามาช่วยสำนักงานโครงการส่วนพระองค์สมเด็จพระเทพรัตนราชสุดา ฯ สยามบรมราชกุมารี
ในความดูแลของจุฬาลงกรณ์มหา
วิทยาลัยเพื่อพัฒนาค่ายสิ่งแวดล้อมศึกษาสำหรับเยาวชนในเขตโครงการอุทยานธรรมชาติวิทยาตา
มพระราชดำริ ฯ อำเภอสวนผึ้ง จังหวัดราชบุรี
โดยค่ายวิทยาศาสตร์ที่จะจัดขึ้นนี้มีเนื้อหาเกี่ยวกับดินและการอนุรักษ์ดิน
เราต้องการที่จะจัดค่ายนี้ขึ้นอย่างมีประโยชน์สูงสุดแก่ชุมชน
โดยเราต้องการต่อยอดหรือพัฒนาองค์ความรู้ใหม่บนพื้นฐานที่ท่านได้เตรียมไว้แล้วเพื่อหลีกเลี่ยงค
วามซ้ำซ้อนของเนื้อหาและเพื่อให้หลักสูตรน่าสนใจสำหรับนักเรียนระดับประถมศึกษา
เนื่องจากท่านตระหนักดีถึงพื้นฐาน ขีดความรู้และความสามารถของเยาวชนในพื้นที่
พวกเราจึงอยากจะได้คำแนะนำและความเห็นจากท่าน

เราอยากให้ท่านช่วยเราในการจัดค่ายครั้งนี้ด้วย
เนื่องจากเนื้อหาของค่ายนี้ได้วางให้เสริมขึ้นจากเนื้อหาของค่ายที่จัดมาก่อน ๆ
เพิอตอกย้ำกระบวนการปลูกจิตสำนึกด้านอนุรักษ์ธรรมชาติให้แก่เยาวชนในพื้นที่
เราต้องการวิทยากรค่ายหลายตำแหน่ง ตั้งแต่วิทยากรบรรยาย ไปจนถึงผู้นำกิจกรรมต่าง ๆ
โดยทั้งนี้เราเห็นว่าความผูกพันระหว่างท่านและเด็ก ๆ
รวมทั้งความสามารถในการถ่ายทอดความรู้ของท่านเป็นสิ่งสำคัญยิ่งที่จะทำให้ค่ายนี้ประสบความสำ
เร็จ

วันนี้เราได้จัดกิจกรรมขึ้นหลายอย่างโดยมีจุดมุ่งหมายที่จะให้ข้อมูลเกี่ยวกับค่ายสิ่งแวดล้อม
ศึกษาที่จะจัดขึ้นแก่ท่านและเราหวังว่าเราจะได้ข้อมูลที่จำเป็นในการพัฒนาค่ายนี้ให้ดีที่สุดเช่นกัน

- ขั้นแรกเราขอให้ท่านช่วยกรอกแบบสอบถาม
  ข้อมูลที่ได้จะบอกให้เราทราบถึงระดับความรู้ของนักเรียนเกี่ยวกับดิน
- จากนั้นจะมีการสาธิตการทดลองที่จะจัดขึ้นที่ค่าย
- เราได้เตรียมตัวอย่างบทเรียนให้ท่านพิจารณาในการที่ท่านอาจสนใจที่จะเป็นวิทยากรค่าย
- การให้ข้อมูลเกี่ยวกับกิจกรรมค่ายอื่น ๆ
- เราต้องการวิทยากรและทีมงานในการจัดค่ายระหว่างวันที่ 17 ถึง 19 กุมภาพันธ์
  เราจะแจกแบบฟอรม์ให้ท่านเลือกกิจกรรมที่ท่านสนใจเข้าร่วม
  เราหวังว่าท่านคงสนใจที่จะร่วมงานกับเราเพื่อที่จะได้แลกเปลี่ยนความรู้ซึ่งกันและกัน

ขอขอบพระคุณที่ท่านได้กรุณาสละเวลาอันมีค่ามาพบเราในวันนี้

แมทธิว ฟินช์
พอล ฟรายทัส
เคธี่ ฮอลล์
โคเรน โรช

Teacher Survey (แบบสำรวจสำหรับครู **)**

1. We would like to know a little bit about you. This will help us to more accurately interpret the information you give us. (กรุณากรอกข้อมูลส่วนบุคคลเพื่อใช้ในการประเมินแบบสำรวจนี้ด้วย ท่านสามารถใช้ภาษาไทยหรือภาษาอังกฤษก็ได้ในการกรอกแบบสำรวจนี้)

   School (โรงเรียน): _____ Grade

Taught (ชั้นที่สอน): _____

   Subjects Taught (วิชาที่สอน): _____

   _____

2. Please check off whether you have taught any of the following subjects. For each of the subjects you have taught, list the specific topics you covered. (กรุณาเลือกหัวข้อที่ท่านสอนในวิชาของท่าน กรณีที่ท่านสอนหัวข้อนั้นๆ กรุณาบอกรายละเอียดโดยสังเขปของเนื้อหาด้วย)

Subject (วิชา)	Yes (สอน)	No (ไม่ได้สอน)	Topics Covered (เนื้อหาหรือหัวข้อที่สอน)
Erosion (การกร่อนของดิน)			
Soil Nutrients (สารอาหารในดิน)			
Soil Horizons or Layers (ชั้นดิน)			
Deforestation (การทำลายป่า)			
Soil Ecosystem (ระบบนิเวศของดิน)			
Types of Soil (ชนิดของดิน)			
Decomposition cycle (วัฏจักรการสลายตัวตามธรรมชาติ)			
Sustainable agriculture (การเกษตรอย่างพอเพียง)			

3. For any of the subjects below that you have taught, please check all methods of teaching you used, including whether you used in-classroom or outdoor activities.
(กรุณาระบุวิธีการสอนที่ท่านใช้ในรายวิชาที่ท่านสอน กรณีไม่ได้สอนวิชานั้น ๆ ให้ข้ามไป)

Subject (วิชา)	Teaching Method (เทคนิคการสอน)			Location of Activities (สถานที่ของกิจกรรม)	
	Lecture (บรรยาย)	Hands-On Activities (กิจกรรม)	Experiments (การทดลอง)	Inside the classroom (ในห้องเรียน)	Outdoors (นอกห้องเรียน)
Erosion (การกร่อนของดิน)					
Soil Nutrients (สารอาหารในดิน)					
Soil Horizons or Layers (ชั้นดิน)					
Deforestation (การทำลายป่า)					
Soil Ecosystem (ระบบนิเวศของดิน)					
Types of Soil (ชนิดของดิน)					
Decomposition cycle (วัฏจักรการสลายตัวตามธรรมชาติ)					
Sustainable agriculture (การเกษตรแบบพอเพียง)					

4. We understand that your students have a program in which they keep a garden and raise animals. What farming techniques are taught in this program? Please check all that apply.
(กรณีที่นักเรียนของท่านมีโครงการเกษตรกรรมหรือเลี้ยงสัตว์ในบริเวณโรงเรียน กรุณาระบุเทคนิคที่สอนท่านสามารถเลือกได้มากกว่า 1 ข้อ)

___ Plowing (การพรวนดิน)
___ Crop Rotation (การปลูกพืชหมุนเวียน)
___ Chemical Treatments (การใช้สารเคมีในการเกษตร)
___ Field Layout *(for example, contour planting, minimum tillage, cover crops, no-till and the use of perennial plants*) การวางแปลนไร่ เช่น การเพาะปลูกแบบเป็นแนว การเตรียมดิน การใช้พืชคลุมดิน การไม่เตรียมดิน การใช้พืชยืนต้น เป็นต้น

5. Please describe anything you feel would be important to teach the students about soil.
(กรุณาระบุและให้รายละเอียดเกี่ยวกับหลักสูตรเรื่องดินในหัวข้อที่ท่านคิดว่าจะมีประโยชน์แก่เยาวชนในพื้นที่)

_____

_____

_____

_____

Thank you very much for your input. (ขอขอบพระคุณในความร่วมมือของท่าน)

Help request form (**แบบขอความช่วยเหลือ**)

You have already helped us greatly by describing what you teach students in class. We will be using that information to design activities for an environmental education camp in February. We are looking for teachers to give lectures and conduct activities at that camp, and your experience and expertise would be invaluable. Teachers at the camp will be assisted by graduate students from Chulalongkorn University, and will be provided with lesson plans and background material. (**เราขอขอบพระคุณที่ท่านได้ให้ข้อมูลเกี่ยวกับนักเรียนของท่าน เราจะนำข้อมูลเหล่านี้ไปใช้ในการออกแบบบทเรียนและเนื้อหาของค่ายสิ่งแวดล้อมศึกษาที่จะจัดขึ้นประมาณกลางเดือนนี้ เราต้องการครูในพื้นที่เป็นวิทยากรและดำเนินกิจกรรมหลากหลายในค่ายที่จะจัดขึ้นนี้เนื่องจากประสบการณ์และทักษะในการสอนของท่านทำให้ท่านเป็นตัวเลือกที่ดีที่สุด เราได้จัดคณะนิสิตระดับปริญญาบัณฑิตและดุษฎีบัณฑิตสายวิทยาศาสตร์สิ่งแวดล้อมไว้จำนวนหนึ่งเพื่อช่วยเหลือท่าน นอกจากนั้นเราจะเตรียมบทเรียน สื่อการสอน คู่มือครูพร้อมเฉลยไว้ให้ท่านด้วย)**

Please consider devoting some of your time to help us run the camp. If you would like more information before deciding, we can contact you later this week. If you do not feel comfortable teaching at the camp in February, we would still appreciate your participation as an observer at the camp. You can provide insight into the strengths and weaknesses of the program, which will allow us to improve future sessions of this camp. We are also interested in getting you involved with the camp programs here, so that you can extend the lessons given at the camp into your classes.
(**เราหวังเป็นอย่างยิ่งว่าท่านพร้อมที่จะสละเวลาอันมีค่ายิ่งมาเป็นวิทยากรอาสาสมัครให้ค่ายสิ่งแวดล้อมศึกษาที่จะจัดขึ้นนี้ ถ้าท่านต้องการข้อมูลใด ๆ เพิ่มเติมเพื่อประกอบการพิจารณา เราพร้อมที่จะจัดส่งให้ท่านโดยเร็วที่สุด แม้ว่าท่านอาจจะยังไม่พร้อมที่จะเป็นวิทยากรในครั้งนี้ เราหวังว่าท่านจะสามารถมาเข้าร่วมกิจกรรมกับเราได้ในฐานะผู้สังเกตการณ์ โดยเรายินดีรับฟังความคิดเห็นของท่านเพื่อนำไปปรับปรุงค่ายในอนาคต เราหวังเป็นอย่างยิ่งที่ท่านจะเข้ารวมกิจกรรมค่ายในครั้งนี้เพื่อที่ท่านจะได้นำบทเรียนและเนื้อหาใหม่ไปประยุกต์ใช้ในรายวิชาที่ท่านสอนอยู่**)

1. We will be running a 3 day, 2 night environmental education camp at the Suan Phung Office from Friday, February 17th through Sunday, February 19th. We will be teaching the students about soil, specifically about deforestation, erosion, soil nutrients, soil components, and

sustainable agriculture. Would you be interested in teaching at this camp?
(เราจะจัดค่ายสิ่งแวดล้อมศึกษาเป็นเวลา 3 วัน 2 คืน ณ
บริเวณศาลาธรรมชาติวิทยาของโครงการอุทยานธรรมชาติวิทยาอันเนื่องมาจากพระราชดำริ ฯ
ระหว่างวันที่ 17 ถึง 19 กุมภาพันธ์ เนื่อหาในครั้งนี้จะครอบคลุมเรื่องดิน โดยจะเน้นเรื่อง การทำลายป่า
การกร่อนของดิน ธาตุอาหารในดิน องค์ประกอบของดิน และการเกษตรแบบพอเพียง
ท่านคิดว่าท่านสนใจที่จะสอนหัวข้อเหล่านี้ไหม?

☐ Yes (สนใจ) ☐ No (ไม่สนใจ) ☐ Unsure (ยังไแน่ใจ)

☐ I would like more information (ต้องการข้อมูลเพิ่มเติม)

☐ No I would just like to observe (สนใจที่จะมาสังเกตูการณ์)

Could you attend a training workshop in the afternoon on Thursday, February 16th?
(ท่านสามารถเข้าร่วมการอบรมวิยากรค่ายที่จะจัดขึ้นตอนบ่ายของวันที่ 16 กุมภาพันธ์ หรือไม่?)

☐ Yes (ได้) ☐ No (ไม่ได้) ☐ Unsure (ยังไม่แน่ใจ)

☐ I would like more information (ต้องการข้อมูลเพิ่มเติม)

2. Below is a list of environmental subjects. Please check off any you might be interested in teaching at the camp. Teaching materials would be provided for your use, and we will train you in how to use them. These materials would look like the information you were given on the 'Soil as a Filter' exercise we did today. (กรุณาเลือกหัวข้อที่ท่านสนใจจะสอน
เราจะเตรียมบทเรียน คู่มือครู และจะจัดการอบรมให้แก่ท่านด้วย
บทเรียนและคู่มือจะมีลักษณะคล้ายกับกิจกรรมเรื่อง "คุณสมบัติการแทรกซึมของดิน"
ที่เราได้ทดลองทำกันในวันนี้)

Subject (หัวข้อ)	Yes (สนใจ)	No (ไม่สนใจ)	Unsure (ไม่แน่ใจ)	Want more information (ต้องการข้อมูลเพิ่มเติม)
Erosion (การกร่อนของดิน)				
Soil Nutrients (สารอาหารในดิน)				
Soil Horizons or Layers (ชั้นดิน)				
Deforestation (การทำลายป่า)				
Soil Ecosystem (ระบบนิเวศของดิน)				
Types of Soil (ชนิดของดิน)				
Decomposition cycle (วัฏจักรการสลายตัวตามธรรมชาติ)				
Sustainable agriculture (การเกษตรแบบพอเพียง)				

3. If you have asked for more information or have expressed an interest in helping at the camp, we would like to contact you directly! Please let us know who you are and how best to contact you via telephone over the next week. A telephone number where you will be

available during the day would be best, but if that is not possible, we can contact you in the evening as well. (ถ้าท่านสนใจที่จะร่วมงานกับเราหรือต้องการข้อมูลเพิ่มเติม กรุณาเขียนชื่อ ที่อยู่ และเบอร์โทรศัพท์ที่เราสามารถติดต่อท่านได้ระหว่างเวลาราชการ เราสามารถติดต่อท่านในเวลาเย็นได้เช่นกันในกรณีที่ท่าน)

Name (ชื่อ): _____

Telephone Number (เบอร์โทรศัพท์): _____

What times of the day and days of the week can you be contacted at this number

(เวลาที่สะดวกในการติดต่อทางโทรศัพท์?): _____

_____

Thank you very much for considering this request for help. If you have provided contact information, we will be in touch within the week.
(ขอขอบพระคุณที่สนใจและให้ข้อมูลในการสำรวจครั้งนี้ กรณีที่ท่านต้องการข้อมูลเพิ่มเติมหรือสนใจที่จะทำงานร่วมกับเรา เราจะติดต่อมาตามที่อยู่และเบอร์โทรศัพท์ที่ท่านระบุภายใน 1 สัปดาห์)

☺ ☺ ☺ ☺ ☺ ☺ ☺ ☺ ☺ ☺ ☺ ☺ ☺ ☺ ☺ ☺ ☺

Appendix E: Teacher Questionnaire Results

Aacaan Bancha from the BanTagolang School
Grades taught 4-6

Subjects:
Erosion – No
Soil Nutrients – Yes;
    Lectures, inside
Soil Horizons or Layers – Yes;
    Lectures, outside
Deforestation – Yes;
    Lectures, inside and outside
Soil Ecosystem – No answer
Types of Soil – Yes;
    Lectures, inside and outside
Decomposition Cycle – No answer
Sustainable agriculture – Yes;
    Lectures, inside and outside

Did not mark any of the farming techniques

Help Request Form
Would be interested in teaching at the camp, would like more information
Yes he could attend a training workshop the Thursday before the camp
Will to teach anything, wants more information

Khun Den from The Rabbit in the Moon (a conservation organization)
Grades taught 6

Subjects:
Erosion – No
Soil Nutrients – Yes;
    Experiments, outdoor
Soil Horizons or Layers – Yes;
    Outdoors
Deforestation – Yes;
    Lecture, Hands-on activities, Experiments, Outdoors
Soil Ecosystem – Yes;
    Outdoors
Types of Soil – Yes;
    Lecture, Hands-on activities, outdoors
Decomposition cycle – Yes;
    Lecture, Hands-on activities, outdoors

Sustainable agriculture – No;

Help Request Form
Yes to helping/teaching at the camp
Yes to attending a training workshop in the afternoon on Thursday
Willing to teach at camp: soil nutrients, deforestation, soil ecosystem, decomposition cycle

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Khun Phai a volunteer with The Rabbit in the Moon
Grades taught 6

Subjects Taught
Erosion – No
Soil Nutrients – Yes;
    Hands-on activities, outdoors
Soil Horizons or Layers – Yes;
    Lectures, Outdoors
Deforestation – Yes;
    Lectures, Hands-on activities, Experiments, outdoors
Soil Ecosystem – Yes;
    Lecture, Hands-on activities, outdoors
Types of Soil – Yes;
    Lecture, Hands-on activities, outdoors
Decomposition Cycle – Yes;
    Lecture, Hands-on activities, Experiments, outdoors
Sustainable agriculture – No;

Help Request Form
Yes to helping/teaching at the camp
Yes to attending a training workshop in the afternoon on Thursday
Willing to teach any subject at camp

Khun Suthep Krithep (Park Staff)
Grades taught Primary School

Subjects Taught
Erosion – Yes;
    Lecture, Hands-on activities, experiments, outdoors
Soil Nutrients – No
Soil Horizons or Layers – Yes;
    Lecture, outdoors
Deforestation – Yes
    Lecture, Hands-on activities, outdoors
Soil Ecosystem – Yes
    Lecture, Hands-on activities, outdoors

Types of Soil – No
Decomposition cycle – Yes
Lecture, Hands-on activities, outdoors
Sustainable agriculture – Yes
Lecture, Hands-on activities, outdoors

Checked all farming techniques

Help Request Form

Yes to helping/teaching at the camp
Yes to be able to attend training
Willing to teach any subject

Aacaan Cheelio director of the BanTagolang school
Grades taught 4-6

Subjects taught:
Erosion – Yes;
Lectures, outdoors
Soil Nutrients – Yes;
Lectures, inside
Soil Horizons or Layers – Yes;
Experiments, outdoors
Deforestation – Yes;
Hands-on activities, outdoors
Soil Ecosystem – Yes;
Hands-on activities, outdoors
Types of Soil – Yes;
Experiments, inside
Decomposition cycle – Yes;
Experiments, outdoors
Sustainable agriculture – Yes;
Hands-on activities, outdoors

Checked all farming techniques

Help Request Form
Yes to helping/teaching at the camp, Would like more information
Unsure whether he could attend the training day
Willing to teach any subject at camp

Aacaan Teerawut Rukhaqee (teacher at Ban Bo Lee)
Grades Taught 2-3

Subjects: Math and Foreign Language

Subjects Taught:
Erosion – No
Soil Nutrients – No
Soil Horizons or Layers – No
Deforestation – Yes;
Soil Ecosystems – No
Types of Soil – No
Decomposition Cycle – No
Sustainable Agriculture – Yes;

They feel it is important to teach: train more about soil ex. Fertilize soil to get high nutrient in the limited area

Help Request Form
Yes to helping/teaching at the camp and would like more information
Would like more information before they decide if can come to the training session
Willing to teach any subject

Aacaan Samkiat Srisawat (teacher at Ban Huayphak School)
Grades taught 4-6
Subjects: Thai, English and occupation/technology

Subjects Taught:
Erosion – No
Soil Nutrients – Yes;
Lecture and Experiments
Soil Horizons or Layers – No
Deforestation – No
Soil Ecosystems – No
Types of Soil – No
Decomposition Cycle – No
Sustainable Agriculture – Yes; Lecture

Checked Plowing and Crop Rotation

Feel important to teach: type of soil, using different type of soil for agriculture, soil maintenance/protection

Help Request Form
Willing to teach or just observe and wants more information
Unsure whether he could attend training
Willing to teach deforestation and wants more info

Aacaan X (report group 2)
Grade: 4
Subject: Thai, science, math, English, computer

Subjects Taught:
Erosion – No
Soil Nutrients – Yes;
Hands-on activities, outside
Soil Horizons or Layers – Yes;
Hands-on activities, outside
Deforestation – Yes;
Hands-on activities, outside
Soil Ecosystems – Yes;
Hands-on activities, outside
Types of Soil – Yes;
Hands-on activities, outside
Decomposition Cycle – Yes;
Experiments, inside and outside
Sustainable Agriculture – Yes;
Lecture, outside

Checked Plowing and Crop rotation

Feel important to teach: soil improvement, soil composition (mineral)

Help Request Form
Yes to helping/teaching at camp
Yes to attending training
Willing to teach soil nutrients, soil ecosystem and decomposition cycle

---

Aacaan Prapaporn Hongkaew (Pook) (reporter group 2)
Grades taught 4-6
Subject – Science

Subjects Taught:
Erosion – No
Soil Nutrients – Yes; Concept of N-P-K
Lecture, inside
Soil Horizons or Layers – No
Deforestation – No
Soil Ecosystems – No
Types of Soil – Yes;
Hands-on activities, inside

Decomposition Cycle – No
Sustainable Agriculture – No

Checked Plowing and Field Layout

They feel it is important to teach: 1. soil maintenance 2. soil development 3. soil protection

Help Request Form
Yes to helping/teaching at camp
Unsure if can attend the training
Willing to teach soil horizons, deforestation and soil ecosystem

---

Aacaan Y (reporter group)
Grade: 5
Subject: all subjects

Subjects Taught:
Erosion – Yes; soil destruction
    Lecture, inside
Soil Nutrients – Yes; soil composition
    Lecture, inside
Soil Horizons or Layers – Yes; soil layer
    Lecture, inside
Deforestation – Yes; forest destruction
    Lecture, inside
Soil Ecosystems – Yes; soil ecology
    Lecture, inside
Types of Soil – Yes; soil type
    Lecture, Hands-on activities, Experiments, inside and outside
Decomposition Cycle – No
Sustainable Agriculture – Yes; Royal agriculture project
    Lecture, inside

Checked Plowing, Crop Rotation, and Chemical Treatments

Feel important to teach: method to improve soil quality

Help Request Form
Would like more info and unsure if wants to teach willing to just observe
Unsure if can attend training day
Willing to teach any subject, wants more information

Aacaan Prayong Yongamnoy (teacher at Ban Huay Pak)
Grade : 6

Subjects: Math and Science

Subjects Taught:
Erosion – No
Soil Nutrients – Yes; Humus
    Lecture, inside
Soil Horizons or Layers – Yes; Soil layer, stone formation
    Lecture, inside
Deforestation – No
Soil Ecosystems – No
Types of Soil – No
Decomposition Cycle – Yes; the erosion of natural material
    Lecture, inside
Sustainable Agriculture – No

Checked plowing

Feels important to teach: 1.how to find nutrient in soil 2. soil quality improvement

Help Request Form
Wants to just observe camp
Can attend training
Teach soil nutrients

Aacaan Z
Grade: 6

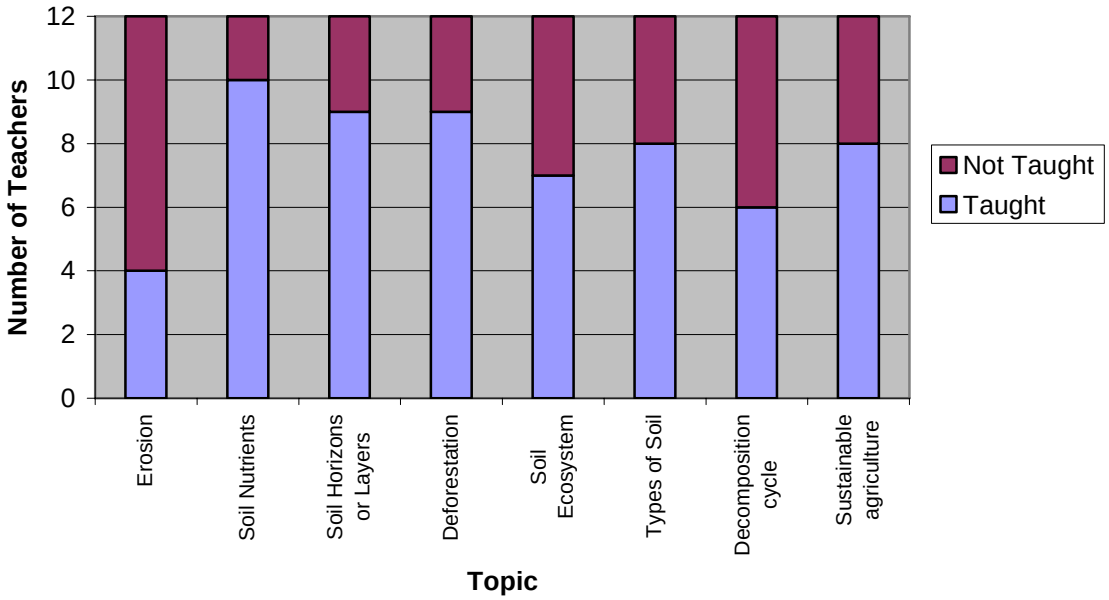
Soil Subjects Taught:
Erosion – Yes;
    Experiments, inside and outside
Soil Nutrients – Yes;
    Lecture, experiments, inside
Soil Horizons or Layers – Yes;
Deforestation – Yes;
    Hands-on activities, experiments, outside
Soil Ecosystem – Yes;
Types of Soil – Yes;
    Experiments, inside and outside
Decomposition Cycle – No
Sustainable Agriculture- Yes;
    Hands-on activities, outside

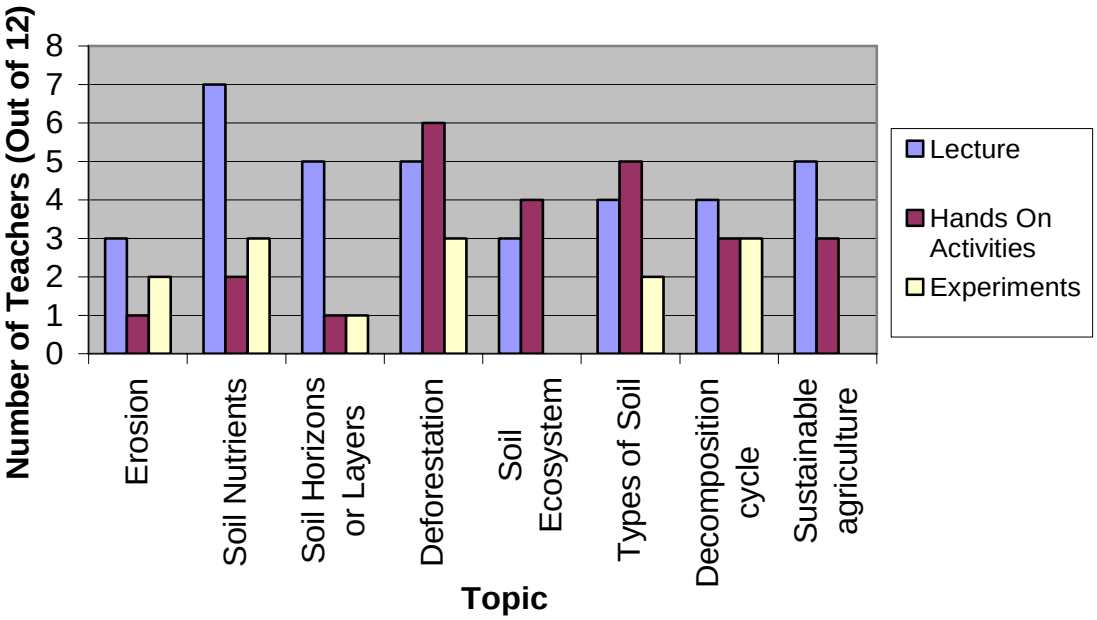
Checked plowing, crop rotation and field layout

Help Request Form

Willing to teach/help at camp
Unsure if able to attend training
Willing to teach any subject

Subject	Lecture	Hands On Activities	Experiment	Inside	Outside
Erosion	3	1	2	2	3
Soil Nutrients	7	2	3	6	3
Soil Horizons or Layers	5	1	1	2	6
Deforestation	5	6	3	2	7
Soil Ecosystem	3	4		1	5
Types of Soil	4	5	2	5	6
Decomposition cycle	4	3	3	2	5
Sustainable agriculture	5	3		2	5




Number of Teachers (Out of 12)
0
1
2
3
4
5
6
7
8
Erosion
Soil Nutrients
Soil Horizons or Layers
Deforestation
Soil Ecosystem
Types of Soil
Decomposition cycle
Sustainable agriculture
Topic
Lecture
Hands On Activities
Experiments

Appendix F: Camp Educational Objectives

At the end of the program, students should:

(General Soil characteristics)

- understand that soil changes usually take an extremely long time
- understand that the soil has many layers—from the pure organic material at the top, to the bedrock, or parent material, at the bottom
- be able to identify physical characteristics of good soil without tools, by touch, sight and smell.
- be able to distinguish between sand, silt and clay by the size of the soil particles
- be able to list the following characteristics of good soil
    - It has a lot of fauna—insects and earthworms
    - Has a good supply of nutrients & have a good nutrient-holding capacity
    - Has good aeration (plant roots need air too!)
    - Has a lot of organic matter in it (Humus)

(Importance of soil)

- be able to list the following benefits of good soil
    - For humans:
        - Healthy plants grow well from it—it supports agriculture
        - It retains water & nutrients
        - Filters some pollutants from groundwater->cleaner lakes and streams
    - For the environment:
        - Healthy soil supports a healthy ecosystem
- understand that there is a succession of ecosystems that thrive on poor soil, and make the soil hospitable for the next generation.
- know the aspects of the soil that are important to plant growth, namely
    - Nutrients and nutrient-holding capacity
    - Water and water-holding capacity
    - Aeration

(Threats to soil)

- be able to identify erosion and nutrient loss as major factors in soil degradation.
- understand that human actions threaten the soil, and some specific means by which it can be hurt:
    - Deforestation (erosion)
    - improper agriculture (erosion and nutrient loss)
        - No crop rotation or fallow years (nutrients not replenished)
        - Burning excess plant material at the end of a growing season (nutrients not replenished)
        - Poor layout of crops (erosion)

        - Excessive tilling (exposure of soil → erosion)
    - mining (erosion)
    - overgrazing (ground cover loss → erosion)

(Soil Nutrients)

- have knowledge of the nutrient cycle—organisms decomposing, nutrients being taken up by plants, animals eating plants, animals & plants dying and decomposing.
- know where nutrients come from:
    - weathering of the parent material (mineral nutrients)
    - decomposition of organic material
    - fertilizers from humans

(Erosion)

- Understand that erosion is an important natural process, but that human actions can make it happen unsustainably fast
- List ways to protect against erosion
    - Plant cover
    - Contour farming (furrows perpendicular to hill slope)
    - Terracing

(Reforestation)

- Describe what the Park is doing in its reforestation work, including:
    - Naming the problem that the work is trying to fix—loss of nutrients/reduction to sand/degradation of the soil by tin mining/agriculture to a point so that few plants could grow
    - Recognizing that the soil in the reforested area is much better than that at the tin mines, but that it is still not as good as the untouched forest soil.

Process objectives:

- Students should be interested in and enthusiastic about activities
- Students should think critically and identify key ideas on their own, with some leading from instructors
- Students should work with group members, and communicate ideas and observations to each other
- Students should feel motivated to continue conservation work after the program is done
- Local teachers should help the camp teaching process
- Local teachers should gain some ideas for extensions to the program they can provide in their classes
- Teachers for the program should be given enough background material to be able to adequately answer student questions.

Appendix G: Proposed Schedule for the Trial Implementation of the Camp

Feb 17-19, 2549	Activity	Topic	Objective
Day 1			
800	Larger Group Ice Breaker		
830	Break into small groups. Group time to come up with name		
900	Welcome Speech/Opening Ceremony		
930	Pretest		
945	Break		
1000	First Lecture	Basic Soil Science, Soil Characteristics, Soil Layers	Give students knowledge for activities
1100	Just Passing Through	Soil's ability to retain nutrients/pollutants and water	Show how different types of soil are better for plants
1200	Lunch		
1300	Fun activity (game and songs)	Soil related	
1400	Erosion in Action	Different Field layouts effect on crops	Show good crop layouts
1500	Break		
1520	Follow-Up Erosion Activity		
1620	Review Game (bingo)		
1700	Free Time		
1800	Dinner		
1900	Night Time Fun (Songs, Stories,etc)		
2100	Bed		
Day 2			
600	Morning Exercises		
645	Shower/Baths		
730	Breakfast		
815	Soil Scientist Intro	What is a scientist?	Intro into days activities
845	Groups 1 & 2 begin Soil Scientist activity Groups 3 & 4 play team building games		
915	Groups 3 & 4 begin Soil Scientist activity		
1015	Break		
1130	Groups 1 & 2 begin Soil Scientist activity Groups 1 & 2 have lunch at waterfall		
1200	Groups 3 & 4 have lunch at waterfall		
1245	Groups 1 & 2 visit last site		
1315	Groups 3 & 4 visit last site Groups 1 & 2 play team building games		
1345	Fun Activity		

	Activity	Topic	Objective
1430	Collect data from Soil Shake Test	Parts of Soil	Show the difference in the soil samples taken that day
1500	Break		
1515	Discuss findings, groups prepare findings for a presentation		
1615	Presentation		
1800	Dinner		
1900	Night Time Fun, songs, Vow		
2200	Bed		
Day 3			
730	Breakfast		
815	Sustainable Agriculture Activity	Discussion about sustainable farming techniques	
915	Write Postcards		
945	Conclusion Speech / Post test		
1045	Closing Remarks, Thank you for coming, Certificate Ceremony		
1200	Lunch and Leave		

Appendix H: Pre- and Post-Test for the Trial Camp

1. What three things is soil made of?

2. Name at least 3 characteristics of good soil

3. What characteristics of soil are important to plant growth?

4. Name at least 2 ways humans can help cause erosion

5. List at least 2 examples of poor farming methods

6. Please describe or draw the nutrient cycle

7. Name at least one source of soil nutrients

8. List at least 2 ways to prevent erosion

9. Describe how the park is helping with the forests

Appendix I: Observation Forms for the Trial Implementation of the Camp

Group Name: _____ Observer: _____

Activity: _____ Date/Time: _____

These observation sheets will be used to identify students' reactions to activities in order to provide information for future improvement. Place a mark each time a student engages in one of the actions listed. Please also record any interesting events that take place in the comments section.

Group Member	Contributes Ideas	Asks a clarification question	Asks for more information	Encourages others to participate
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

The activity ended: __on time __early __late __did not finish

Was there anything that students had a particularly hard time understanding or asked a lot of questions about?

COMMENTS

Appendix J: Notes on Camp Debriefings

Translated by Dr. Siripastr

J-1 Day 1 Debriefing

- Camp started late so that delayed everything, weren't planned well for registration and students arrived late. There was a problem with morning planning management
- A more formal opening speech with a big shot it needed
- Pre-Test was bad
    - Our idea for questions that were not leading back fired and confused students
    - Test was to lengthy most students didn't finish
    - Multiple choice or fill in the blank questions are better and having less questions
- The first lecture had to be cut short
- English minutes are good
- Rabbit and the Moon VP- asked why we chose soil. Somphop explained that it wasn't covered at previous camps and it is really important. Sutep added emphasis on its importance.
- The First activity
    - The worksheets should be side by side instead of one after the other because that was confusing
    - Hypothesis section had two many questions and took too long
    - Content to advanced, better for secondary schools
    - Better if only one worksheet per group and then other students copied
    - The local students are as developed as the city kids because they are not Thai, they have communication issues because of that scientific understanding is very difficult
    - VP- hands on experiments is best and verbal description is not good for these students
- Second activity
    - VP- he thinks a better model for erosion activity is if more exact measurements of water that washed and seeped in were taken
    - Activities are too hard and instruction not well
    - Kay thinks it is an excellent activity but cut back to two models and leave higher scope for secondary school
    - Toey said that the groups of students we went to interview were smart kids and these aren't the same ones
    - Kay said to add cotton pad on top of furrows to better demonstrate the effect
    - Koren spoke about the dimension of furrows being to complicated
    - Matt added that in the future there should be diagrams of each model
- Need more ice breakers so kids interact. Sutep said that students usually come half a day before to do ice breakers
- Next day changes:

- Number of testing sites cut down and leave time in the morning for more icebreakers. Add more time for playing. Can test was scratched. No soil formation site. Kept:
    - Garden
    - Bamboo/charcoal
    - Mine
    - Big tree
- Suwat set staff at each site. The ones in the woods had two Chula students and a park staff.

J-2 Day 2 Debriefing

- Hike site 1: no problems, Chula students forgot to brig water but after that ok. They didn't do checklist so they forgot some things but point still got across.
- Site 2: Toey very happy, no problem, children were very excited. Some children make charcoal at home and knew consequences. Toey discovered that what they learned about flow chart at site 1 they remembered and were able to teach her. They catch on quick.
- Site 3: Students got bored because this was the third straight time they did the same experiments. Chula students had to work hard to gain attention. Khun Suthep also agreed adding they looked hot and tired.
- Site 4: No problem, great response
- VP- thinks that the level of collecting scientific data was too much. The leaders worked closely though and they really helped to stimulate children. It is encouraging that students were getting into the activities even though they were frustrated from little knowledge of lab procedures.
- Future Recommendation : Sanuk in between site 2 & 3
- Shake Test: A lot more participation from yesterday. Students were able to process information better. They were more comfortable with each other and the staff. This experiment is just right. It was nice that they were able to get answers right away.
    - For the shake test the sediment took a while to settle so the activity didn't finish until close to six. We brought up that we had originally planned to start the shake test before fun activities so that may have helped.
- VP- Flow chart and ribbon test were rough, there were two many variables. Directions should be more specific with exact amount of soil, water and size of ribbon (width and length)
- It was mentioned that tests would need to be run before hand to identify the ideal dimensions
- Khun Suthep mentioned that the amount and location of pressure you put on the soil was also a variable
- Suwat commented about the schedule of stacking the group's departure, and if the first group that arrived back stopped the fun right when the second group arrived then the second group would feel bad. So we need to find a rotation that would prevent this and still get the activity done before six.

    - Aacaan Siripastr told Chula students that they should have warned us about the night time skits instead of it being a surprise for us.
    - Night time activities:
        - Toey- Groups performed just towards the head guest
        - A bit long during the speaking your feelings part
- Khun Suthep was not happy with big brothers. They weren't staying with their groups. Big brothers should help to clarify learning more and should be closer to the students
- We suggested having more than one big brother because it is hard for one person to stay with the same group for so long
- We asked why he feels that the big brothers aren't doing their part. He said that at base three they should have helped stimulate the children to be more active.
- Kay thought that once at a base the people stationed there took over and at the third base everyone was tired and the big brothers did the right thing by not yelling at the kids to motivate them. It would have stressed the kids out. She agrees we need more big brothers/sisters
- FOR TOMORROW:
    - Siripastr will pick topics that were understood to reinforce in a lecture. Plays showed that they remembered everything!
    - Milk- group presentation with poster which can be any style for sustainable agriculture
    - Then post-test will be given verbally to fix wording issues in the questions that caused confusion in the pretest. Questions will be the same though.
    - Certificate lunch and DONE!

J-3 Day 3 Debriefing

- Activity Four: EXCELLENT!!
    - Participation was outstanding, especially with exchanges in conversations
    - Red Group: 3 people didn't want to participate but instead wanted to learn English so they went off.
    - The ducks: were excellent.
    - The blue group: came up with their own parts for the poster, there was no brainstorming or collaboration and Suwat had to get them to bring everything together
    - Yellow Group: started with a brainstorm and then split jobs and helped each other and worked on organizing the presentation.
- Last lecture: went very well students knew the answers. Dr. Siripastr had a great setup with posters
- Post-test: some questions were still confusing. They think it is still the wording of the questions. They also had trouble since the questions were rephrased from the lecture.
- Closing ceremony: Went well
- Khun Somphop: says he will keep the program. He hopes another group will come next year. Being the 4th group we helped him to visualize points the other groups had made. He now has a water and soil camp so he can run a complete set.

Appendix K: Translated Letters of Evaluation from Camp Staff

These are letters that we received from camp staff after the conclusion of the camp. All are translated by Dr. Siripastr

K-1 Letter from Director Cheelio

Problems:

- Communication, because designer needs experience, transferring process of knowledge and objectives and approach is not 100% effective
- Design of activities is too difficult for elementary school students in remote area, where teacher could not provide enough basic scientific knowledge
- Knowledge of students from different schools is different, so thinking process and deduction process more difficult and complex
- Staff comes from many groups lack coordination and good planning took a while to get one another together – if you can get staff, lecturer that are skillful this is better more experienced

K-2 Letter from Sompop

- Pretest/posttest: evaluation process esp. for env camp should use different form such as games or behavior observations this is because I noticed that pretest was a failure because the students who attend the camp have problems with reading and writing and could not understand the questions; however, for the post-test, children performance was better because the staff is always remind them of the key concepts and there was a summary before the post-test. To obtain the evaluation that truly represent the development of children, we should provide a period after the camp and evaluation should be the same one, so that you can compare the data.
- Curriculum objective should be set then, built up activities and detail that is suitable for the group. If you do this way then the design of activities will be very interesting to the children. Also, should consider using natural resources as tools to stimulate learning and should involve students with nature as much as possible.
- First Lecture: too much lecture, students are bored; maybe be better to have group discussion with short lecture by staff. Open activities such as sitting in circle, close eyes and touch objects so that students can feel the different types of soils, pebbles, stones, loam, sand, mud, etc. and this will guide them more effectively into class activities.
- Soil Layers: too deep for elementary students
- Soil characteristics: interesting, comparing people to different soils is very good;
- Nutrients in soil cycle: should lecture students on this, but maybe use other types of concepts like games and then summary at end
- Human impacts: I think this is inappropriate for this camp, because I think the structure of the curriculum of the camp should start with basic soil, too soon. Start with basics

- Activity one: just passing through: good, but I see that the stuff is not well prepared, so maybe next time should really try to correct error
- Activity 2: maybe better use, plastic box, because soft shoe box deforms and gets wet and leaks, also the box size used are too small, manual should mention packing process, because some group pack too tightly, some too loosely. Directions should also mention dimensions and number of steps. Should change the use of cotton pad into branches or weeds and also should put these materials on the other boxes as well. If possible move experiment to real farm or model for experiment. Also, maybe it's better to have model to correct errors and have the students come help or observe and have the whole class discuss. Lab filters are no good.
- Activity 3: very interesting activities; should improve the soil texture flow chart and make simpler and allow children to do it themselves. Feed them too much info; let them figure it out themselves. Maybe soil shake test can be eliminated because it takes so long and replaced with another activity that takes shorter time. Decision to eliminate or get new activities should incorporate objectives
- Sustainable Agriculture: lecture should not lead into use of soil, but should build some sort of activities that make students realize the use of soil and the consequence of our activities. Then we should set up a theme or questions for each group so they can discuss and come up with their own idea. Then discussion by lecturer should be at the end after groups present, followed by the lecture on sustainable agriculture.
- Worksheets/Student Manual: difficult to read, understand, record, not very interesting, doesn't think that students want to read it again.

K-3 Letter from Pooh

- Total impression: because of area of nature education park has problem from previous mining activities, slash and burn agriculture, coal pit, so forest and soil are destroyed so therefore the main objective for environmental camp to teach local students to realize the true problems and make a better choice of sustainable agriculture. The staff has incorporated the knowledge on soil, types of particles, and of good soil. Team set up a camp to cover soil composition, particles, factors of good soil, how to protect topsoil and sustainable agriculture
- Camp activities: first day – students from both schools didn't now one another, shy. Creates a problem in activities 1 and 2 because groups split. Maybe we need some sort of activity to stimulate cooperation – icebreakers. Activities very good and teach students to see difference in different types of soil – different soil filtration between loam and sandy soil which reflects nutrients absorptions – absorptions of nutrients and bad chemicals; however directions should specify the soil weight and soil moisture, quantity of water used and concentration of dye. Also, size of bottles, bottles should be clear, so students can observe changes. Moreover, if we have weighing of soil, then that will clearly show students that water stays in the soil.
- Second activity: students model 5 farming techniques which they can conclude that using plants to cover topsoil is best, because plants store a lot of water. However, I suggest that for the ditch should have something to cover. Directions should have pictures of each exp set up

- DAY TWO: survey soil in different areas tells students on types of soil particles size that relate to the ecosystems so the students visit 4 sites. First site at green house, good soil. 2nd are bamboo trees, deserted area with coal pit. 3rd is mining area. 4th is fertile soil. At each base students did experiments to determine particle soil and identify soil composition. I think that the questions in the hypothesis sections are similar and too many and students waste a lot of time writing and thinking about it – it is better if we used a table so that at the end, overall picture and comparison can be seen.
- Campfire: great fun and children had a chance to express their feelings by a play. I noticed that the children can adapt knowledge from class very creatively and natural regardless of short notice.
- THIRD DAY: sustainable agriculture – children split into groups and worked on art together. Results show that children understand the concept of sustainable agriculture and they use their creativity to express this knowledge and present their ideas of SA very well. All of them and enjoy and had fun in activities.
- Curriculum: good one – provide knowledge and understand to them on soil that is connected to true problems in area and offer solutions through sustainable agriculture. This curriculum can be adapted for higher level students by adding scientific instruments (tools), maybe digging to observe true soil profile. Maybe actually conduct experiment at each base to study animals in soil.
- Problems and obstacles: because WPI team needs to change topics to reflect the local problem, this gave them only very limited time to set up experiment. Moreover, the information needs to be all in Thai so it takes a lot longer to prepare. Communication problems Thai enlist, local dialect, poor communication skills of local students – critical to reduce number of questions – stress discussions, Q&A sessions, maybe add pictures to ask questions and use more tables for recording.
- Success: program received from cooperation and support from so many parties, education directors, local directors, local schools, rabbit in the moon (fun act) staff of nature ed park, Chula students, everyone work very hard and the camp received great success. Good example of building network among many parties and exchange knowledge and collaborate in all aspects (knowledge, experience, languages, culture) sharing all this. Local teacher team were extremely impressed with activities and format of camp, also the teaching style such as scientific activities with hands on experience. I see that even though some exp are quite complicated the students are interested and happily learn topics. I see that students receive knowledge and gain great understanding in local soil, soil nutrient soil cycle and characteristics of soil results of slash and burn, deforestation and how to protect soil via sustainable agriculture. Children are impressed with the WPI team and they learn English very well. I see that this is a great success in environmental cap and we should support and bring the curriculum for further use.

Mr. Vichen (Rabbit in Moon)

- Camp Organization

1. Topics on soil very interesting, because it is so close to students, however children know about soil very little (scientific knowledge) appropriate and good basis for further education
2. sequence of act: I think that act. On day 2 should be on day one, because act. On day 2 are all about soil structure and types and characteristics which are the fundamentals of

day one. Filtrations of soil. All these in different soil. I understand that the designer wanted to link act. 1 to soil erosion in deforestation area.

3. For educational camp on nature education alone: ratio of students to staff 1:10 to 1:20, but if we want to have the students understand nature in detail, then the ratio should be not go beyond 1:10. This is because the big brother must gain the trust from the children first before able to transfer the conservation concepts to students (1:5). Experimental part: everyone should participate – in this camp only a few, most are observers. Maybe groups are too big.
4. for the camp that intend to build knowledge in nature education for conservation, then have to have consecutive camps to keep building understanding. From my experience, the best camp for this purpose should be in a series of 4 to 6 in one year. Then we see a big difference in children's understanding and feelings about conservation.
5. Strategies in transferring knowledge should include:
    - All activities should be fun (sanuk)
    - Content of activities must be exciting and clear so that we keep there attention, for example the soil composition can be touched by hands, observed by eyes, microscope to see deep down (sandy soil – see particles or compositions of clay or small animals that live in soil) this will excite them by showing them a world they never noticed. Activities will stimulate students for further knowledge.
    - Presentations at end because the students must pay attention in class and must understand content, otherwise they cannot present, they will feel embarrassed.

   Personal experience: in my organization also design a curriculum on ecosystem into y6 camp. 1 intro to greenhouse effect 2. camp on producers, 3 consumers 4 decomposers 5 forest and streams 6 mangrove forest. Due to limited funding and staff, we can only select 25 children by interview. After camp, we set the path for each child that he must find a friend that didn't participate and transfer his knowledge to his friend. Camp 1-5 just lecture and then after he transfer the knowledge, then at camp 6 both kids get to go and participate by the sea. Reward. Not every pair get to go to mangrove forest, so each partner must come for interview and committee asks them questions about content about the camps, those that perform well are rewarded to attend the sixth camp.
6. Longer icebreaking activities if children are from different schools.

Appendix L: Final Camp Material

Time	Activity	Topic	Objective
Day 1			
1400-1500	Students Arrive		
1500-1600	Introduction games and break students into groups		Introduce student's names and separate groups
1600-1700	Welcome Speech/Opening Ceremony		
1700-1730	Group time to come up group name and cheer		
1700-bed	Dinner and fun team building activities	Team Building	Have students begin working together with big brother or sister
Day 2			
600	Morning Exercises		
645	Shower/Baths		
730	Breakfast		
800	Environmental Songs		
900	Pretest		Determine what students know before the camp
930	Break and game		
1000	First Lecture	Basic Soil Science, Soil Characteristics, Soil Layers	Introduce students to material
1100	Filter - Just Passing Through	Water and soil interactions	Teach soil characteristics and scientific process
1200	Lunch		
1245	Fun activity (game and songs)	Soil related songs	
1300	Finish and Conclude Just Passing Through		
1400	Fun activity (game and songs)		
1430	Erosion in Action	Erosion, farming techniques	The relation between field layout and erosion
1530	Break and snack		
Time	Activity	Topic	Objective
1550	Finish and Conclude Erosion in action		
1700	Free Time		
1800	Dinner		
1900	Night Time activities (songs, dancing, games)		
2100	Bed		
Day 3			
600	Morning Exercises		Intro into days activities

645	Shower/Baths		
730	Breakfast		
815	Soil Scientist Intro		Introduce the experiments they will be doing
845	Groups 1 & 2 begin Soil Scientist activity Groups 3 & 4 play team building games		Examine the relationship between land use and soil quality
915	Groups 3 & 4 begin Soil Scientist activity		
1015	Break		
1130	Groups 1 & 2 have lunch at waterfall		
1200	Groups 3 & 4 have lunch at waterfall		
1215	Groups 1 & 2 visit last site		
1245	Groups 3 & 4 visit last site Groups 1 & 2 play team building games		
1315	Quick Fun Activity		
1345	Begin Soil Shake Test; Discuss findings		
Time	Activity	Topic	Objective
1415	Songs and fun activities		
1515	Collect data from Soil Shake Test, groups prepare findings for a presentations		
1615	Presentations and Conclusion		
1700	Free Time		
1800	Dinner		
1900	Campfire and Vow Ceremony		
2200	Sleep		
Day 4			
730	Breakfast		
815	Fun games and songs		
900	Prepare posters and presentations		Summarize what they have learned
1100	Review Lecture/Conclusion		
11:30	Post-test		
12:00	Closing Remarks, Certificate Ceremony		
12:30	Lunch and Leave		

Table of Contents

Note to Camp Staff and Instructors

The purpose of these activities is to introduce topics important to soil science and conservation. The activities are designed to encourage students to think critically, using the scientific process. The scientific process involves making hypothesis, conducting an experiment and then comparing the results to the hypothesis. The worksheet for each activity guides students through this process.

Along with instructions for performing the activity, background knowledge is included. This information should be reviewed by instructors prior to the activity and it is highly encouraged that instructors also conduct the experiment prior to the camp. With the students in a large group a brief overview of the background information, procedure and goals of the activity should be presented. Students can then break into their small groups, where activity procedures should be discussed again. A good way to do this is to have students explain the instructions to their group leader.

When students are answering questions on the worksheets they may need help. Instructors and leaders should guide students to making the right conclusions. Integrated into the activity instructions are questions that can be asked to help students think through the activity. It is ok if students do not know the answer, provide clues to help them come up with answer and feel free to give them the answer if they are struggling. It is also recommended that answers for the worksheets be discussed by the group and one student only writes down the groups answer. The other students at the end can then copy the answers onto their worksheets. This will help save time and ensure all students are getting the correct answers.

At the conclusion of each activity, it is beneficial to have each group give a short presentation of their results.

First Lecture – Basic Soil Sciences, Geology

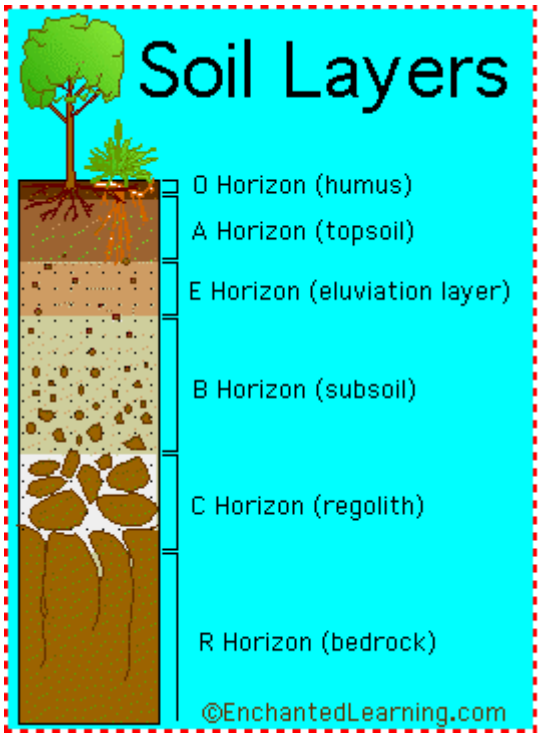
Set-up: Whiteboard with two columns, one column says "Who uses soil" and the other says "How do they use it". Use lots of visuals for this lecture since many students have difficulty understand Thai.

Open Discussion: Ask students "*Who uses soil and how they use it?"* Write answers on bulletin board as given. If needed prompt students to get the following answers:

Plants-Food (stores nutrients), Insects-Homes, Animals- Food and Homes, Farmers-Planting crops, Trees- Support and Food, Humans-to build homes. Wrap up the discussion by drawing the students attention to all the answers they came up with. *"All these things and more that we didn't think of need soil to live. Soil is the basis for all living things. The quality of the soil determines how well plants will grow and how many animals can live there. But how much soil is there for all these living things to use? Let's look at what makes up the soil first.*

First Teaching topic: Soil layers

"The soil is made up of 6 layers, called horizons. Each of these has slightly different qualities. We'll start from the top, the part of the soil we're most familiar with, and move to the bottom."



O Horizon - The top, organic layer of soil, made up mostly of leaf litter and humus (decomposed organic matter).

A Horizon - The layer called topsoil; it is found below the O horizon. Seeds germinate and plant roots grow in this dark-colored layer. It is made up of humus (decomposed organic matter) mixed with mineral particles.

E Horizon - This layer is light in color; it is beneath the A Horizon and above the B Horizon. It is made up mostly of sand and silt, having lost most of its minerals and clay as water drips through the soil.

B Horizon - Also called the subsoil - this layer is below the E horizon. It contains clay and mineral deposits (like iron, aluminum oxides, and calcium carbonate) that it receives from layers above it when mineralized water drips from the soil above.

C Horizon - Also called regolith: the layer beneath the B Horizon and above the R Horizon. It consists of slightly broken-up bedrock. Plant roots do not penetrate into this layer; very little organic material is found in this layer.

R Horizon - The unweathered rock (bedrock) layer that is beneath all the other layers. [1]

Only the top four layers are able to be used by plants to grow and animals to live. This is very small portion of the earth's crust. The little soil there is must be protected by humans so that it can provide for all living things for many years to come.

[1] Picture and information from http://www.enchantedlearning.com/geology/rocks/glossary/ on February 23, 2006

Second Teaching Topics: Soil Characteristics

Ask students for six volunteers (one from each school) and have the rest of the students describe the other students: Eye color, height, skin color, age, etc. Answers will not be recorded and allow responses for a few minutes.

Just like humans have different characteristics, soils also have characteristics. Soil characteristics are used to tell us whether they are good soils or bad and need help to restore. Soils are distinguished by their texture (how it feels in your hands), color, structure, consistency and pores (air space in the soil).

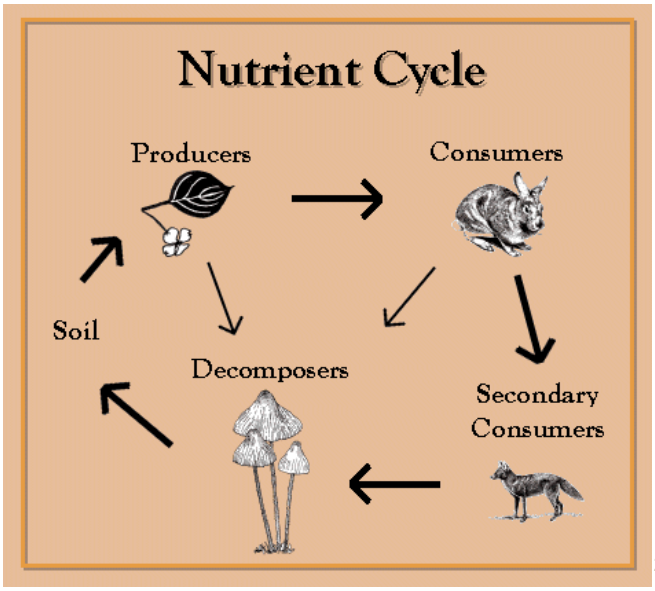
There are three major types of soil: sand, silt and clay. You can tell the difference between these three types of soil by the size of the soil particles in them. Sand has the largest particles: if you look at them under a magnifying glass, they look like little rocks. The other two are smaller. Usually, you can't even see the individual grains of clay. The best kind of soil for growing things is called loam. It is a mix of the three types of soil.

Third Teaching Topic: Soil Quality

But what makes good soil "good"? How do you think people decide what is good soil and what is bad soil? (Listen for answers from the group, don't record, listen for "plants grow well from it") *People say that good soil is soil that grows plants well. Soil that is good for growing plants is good for the environment too: plants give animals homes, food, and shelter. So what defines good soil? What does good soil have that makes plants grow so well?*

That has to do with what plants get from the soil. Plants need a good place for their roots, water, and nutrients. A good place for plant roots allows the roots to breathe and gives the plant support. If it's too hard, the roots can't get through the soil, and can't get air. All plants, of course, need water. The soil has to allow water to penetrate the soil, but still hold onto that water after it has stopped raining. A plant also needs nutrients from the soil. While the plant can make its own food from the sunlight, it can't make everything it needs.

The type of soil called "loam" provides a balance between the three types of soil particles. It is loose enough to allow plants to breathe, but still allows the plant some support. The sand in loam allows water to get into the soil, but the clay particles help it stay there. But there's one more ingredient missing-nutrients.



[2]

Fourth Teaching Topic: Nutrients and the soil cycle

People need a balanced diet to stay healthy, and plants do, too. Plants can make their own food from sunlight, but that's not enough. To protect themselves and grow strong, they need nutrients from the soil.

But how do those nutrients get into the soil? Remember how I told you about the top layer of soil, which has decomposing plants and animals? Well, that is how the nutrients get into the soil. As those organisms break down, the nutrients they used while they were alive get absorbed into the soil. From there, they go into plant roots. Plants use the nutrients to grow, and the nutrients can be found in all parts of the plant. Animals that eat the plants get their nutrients from the plants, and those same nutrients pass to animals that eat them. All of these organisms drop their leaves or dung at some point, and some of those nutrients return to the soil. When any of these living things die, that is another way their nutrients can be added to the soil. Eventually, the cycle starts over again, with the plants taking in the nutrients from the soil.

As you can see, the quality of the soil depends on all of the living things that use it. It, in turn, supports all of those living things, by giving plants what they need to live. When the environment is healthy, nutrients are replaced into the soil as fast as they are used up. The soil,

[2] Picture taken from River Bend Nature center. http://www.rbnc.org/schoolunits/soildecomp.htm Feb. 23, 2006.

animals, and plants live in a balanced ecosystem. The soil stays good, or even improves, and the plants and animals on the land stay healthy. But what happens when humans come along?

Fifth Teaching Topic: Human impacts

People rely on the soil, too. We get our food from plants that grow in the soil, and animals that eat plants in the soil. We usually change the environment to get our food, setting up farms where we can grow these plants and animals. We change the environment for other reasons, too: we need space and materials to build all the things we use. If we are careful when we do these things, changing the environment like that isn't a problem. But sometimes, we forget how we can hurt the environment and don't take as good care of it as we should. Soil is often one of the first things to lose its quality when we do that.

The problem is soil can take a long time to degrade. Remember how I told you that in a healthy environment, the nutrients in the soil are replaced as fast as they are used up? Well, sometimes when people disrupt the environment, they don't always replace those nutrients as fast as they get used up. Sometimes, things people do make the soil lose the organic material and balance of soil types that are so important for good soil. It may take a while, but eventually, the soil can get so bad that no one, not people, animals, or plants, can use it for anything. Has anyone here seen a place like that?

Conclusion: What we can do

If we are aware of how we can hurt the soil, though, it can give us a lot. Being careful to protect the soil well can make a farm productive for much longer. We can keep forests healthy, and get building materials, food and medicines from them for a long time. The idea that we can get what we need from the environment, but not hurt the balance that lets it support itself is called sustainable use. It's not easy for us to live that way; we have to always be aware of how what we do affects the environment. It's much easier to look at what we want right now than it is to think about how we can make sure that we can get what we need for a long time in the future.

But a little bit goes a long way. This weekend, we're going to talk a lot about what humans do to hurt the soil. We'll also talk about what we can do to protect it. If all of us can do just a little bit to protect the soil, we can do a lot together.

Just Passing Through – Instructor's Knowledge

Summary

Certain soil characteristics are important to understand the quality of the soil. In order for healthy plants to grow soil needs to be able to provide them with air, water and nutrients. This activity will show students to see how different types of soil absorb and retain water. Soil needs to be able to absorb and retain water in order to provide for plants. There is a delicate balance needed between infiltrating and retaining capabilities. Holding on to too much water and not letting water infiltrate will lead to erosion by run off. If the soil lets water pass right through, the plants will not get the water they need. This activity will also demonstrate the filtering capabilities of the soil. If the soil filters the water well it can then pull nutrients from water and hold on to them. The soil will also be able to hold onto pollutants. It can prevent harmful chemicals from fertilizers and pesticides from leaching into ground water.

Background Information

All soil characteristics relate to the size of the soil particles. We classify particle size into three categories or soil types. Loam is a special mixture of all three soil types in equal amounts.[3]

Soil Type	Particle Size	Texture
Sand	.05 – 2 mm	Gritty
Silt	.002 - .05 mm	Smooth and slippery
Clay	Smaller than .002 mm	Sticky
Loam	Varies	Not gritty nor smooth

[3] Information adapted from *Underground Adventure* "Soil Critter Field Guide". The Field Museum. 2005

Below is another table comparing the types of soils and important soil characteristics.[4]

	Water Infiltration	Water-holding Capacity	Nutrient-holding Capacity	Aeration	Workability
Sand	Good	Poor	Poor	Good	Good
Silt	Medium	Medium	Medium	Medium	Medium
Clay	Poor	Good	Good	Poor	Poor
Loam	Medium	Medium	Medium	Medium	Medium

Water Infiltration is the soils ability to soak in water. This is a good quality to have in order to prevent erosion form surface run off.

Water-holding Capacity is the soil's ability to hold onto the water once it has soaked in. This provides a reservoir for plants to draw from.

Nutrient-holding Capacity is the soil's ability to hold and bind onto nutrients so that they can be absorbed into the roots of plants.

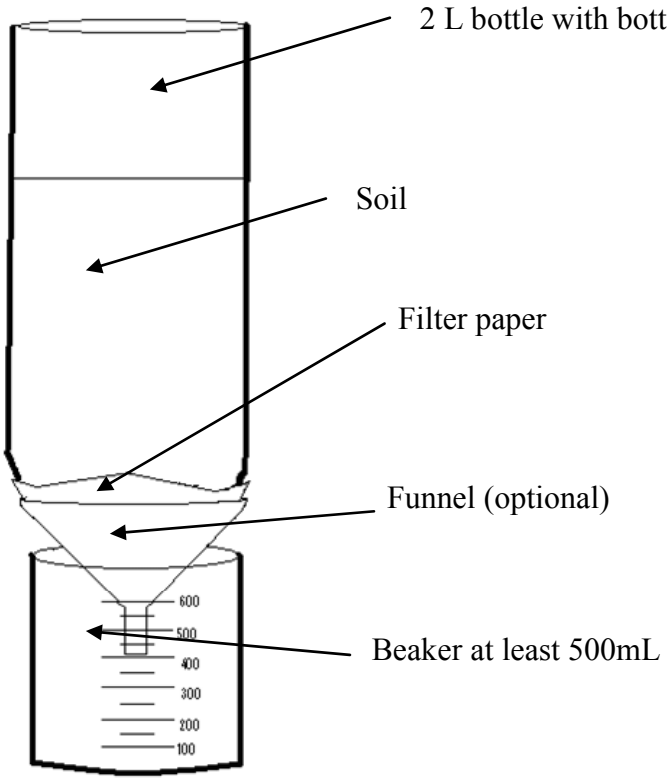
Aeration is a measure of how porous the soil is. Plants need to breathe and porous soil allows for oxygen to be diffused through their roots and for carbon dioxide to be released.

Workability is important for farmers. It is the measure of how easily soil can be cultivated.

The water infiltration, water-holding capacity, and nutrient holding capacity all relate to a soil's ability to filter water. Soil with a high infiltration rate and low water holding capacity such as sand will not filter water well because water passes through before contaminates can be removed. Soils with a low infiltration rate can also be poor filters because rain water will pass over them instead of filtering through. For soil to filter well it must allow water to enter but not pass through too quickly.

[4] Wright T., Richards. *Environmental Science 9th Edition.* Pearson Education, Inc. Upper Saddle River, NJ. 2005

PICTURE OF ACTIVITY SETUP



Title: Just Passing Through – Teaching Manual[5]

Estimated Time: 1 hour

Materials (per group):

- Clear 2 liter bottle, with bottoms cut off
- Two 500 mL beakers or clear containers to catch water
- Soil samples (one loam and one sand)
- Window screen, fine mesh, cheese cloth, coffee filter, etc. This will be used to allow only water to leave the 2 liter bottle
- Water in two 600 mL water bottles
- Food coloring
- Clock, watch, or timer
- Rubber bands

Objective:

- For students to develop the abilities to identify physical changes that occur in soil as water passes through it.
- To improve the students' abilities to design and conduct hypotheses and investigations; properly use appropriate tools and techniques to gather, analyze, and interpret data; and develop descriptions, explanation, predictions, and models based on evidence.

Preparations:

Fill two water bottles with 600 mL water and add food coloring. Make sure soil is dry. Pick out all rocks and sticks and mix soil to make it uniform through out. If possible screen dirt but if not have students break up big clumps of dirt.

Activity:

1. Using the rubber bands wrap the filter material around the spout of each 2 liter bottle
2. Put 1.2 L (or a little more than half the bottle) of a soil into the 2 liter bottle.
3. Have students observe the color, plant matter, and consistency of the soil.
    a. Have them fill in the color of their soil either in a description or with crayons, markers, colored pencils, etc.
    b. Have students look for organic material, and draw what there soil looks like on the worksheet
    c. Have student guess how much water will flow through soil and mark it on their sheets.
    d. Have students mark which container will look most like theirs after the water flows through it.
4. Discuss what will happen to the water when it is poured into the soil and have the students record their hypotheses.
    a. Will the water run out through the bottom of the bottle?

[5] Activty adapted from Ag in the Classroom at http://www.agclassroom.org/teacher/pdf/prairie/6_8/3_justPassing.pdf and Filter activity at http://soil.gsfc.nasa.gov/filter/filter.htm Feb 23, 2006.

b. Will all of it run out of the bottle? How much will run out? Why? [*optional:* mark in a different color marker on the beaker or container the estimates of the students]
c. How long will it take for the water to drain through the soil?
d. What will the water look like when it comes out?

5. Hold the 2 litter bottle over a 500 mL beaker to collect the water.
6. Pour the colored water into soil and begin timer. Discuss and record:
    a. Is the water staying on top?
    b. Where is the water going?
    c. Are there any air bubbles on the water surface?
    d. Is the water coming out look like the water poured in?
    e. Has the soil where the water was poured changed?
7. Stop timer when water drips out slowly, with 8-15 seconds between each drop.
8. Have students compare their hypotheses and results.

Analysis:

9. After water has finished passing through the soil ask students:
    a. Is this the same amount of water we began with?
    b. How can we determine if it is the same amount of water?
    c. [After pouring water back into original container] How much water is missing?
    d. How can we measure the missing water?
    e. Is there a difference between the hypotheses and the actual amount of remaining water?
    f. Can we measure this difference?
    g. What happened to the missing water?
    h. Is the water clearer than when it went in? Why?

Conclusions:

10. Discuss with students what would happen if you added another 300 mL of water to the already saturated soil and record hypotheses.
    a. Will more, less, or the same amounts of water pass through the soil?
    b. Will the water pass through the soil faster, slower, or at the same speed as last time?
    c. Will the water be the same, dirtier, or clearer than last time?
11. Brainstorm with students how this demonstration relates to pollution of groundwater from pesticides or excess soil nitrogen fertilizers.
    - Would there be a difference in pollution between lands growing a crop and those that are not?
    - Discuss the idea that sandy soil filters water the least. Rich, loamy soils full of organic material filter water the best. This helps to prevent harmful substances from entering groundwater, but it still gets trapped in the soil.
    - If the soil is sandy, harmful chemicals and excessive amounts of nitrogen would leach into groundwater. The groundwater and toxic chemicals would eventually feed into a local water reservoir, harming the health of both humans and animals.
    - Excessive amounts of nitrogen or nutrients from fertilizers in a water system, causes eutrophication. In this process, species such as phytoplankton begin to have an extremely high rate of growth and reproduction. This is eventually offset by a

balanced level of die-off, resulting in high amounts of deposits on the bottom of the river. High amounts of debris require high amounts of decomposers, usually bacteria. The bacteria multiply quickly, because of the excessive amounts of material to be decomposed. More bacteria mean that more oxygen in the water is being used than normal. The levels of oxygen in the water begin to decrease and cause the suffocation and eventual death of fish and shellfish.

12. **Optional Extension of Activity***:* Pass the water through the saturated soil. Keep the time, observe the results, and compare:
    a. Did the water flow faster? How do you know?
    b. Did more water flow out? How do you know?
    c. Is the water clearer than the first time? Why?

Erosion in Action – Instructor Knowledge

Summary

Erosion is the most dramatic and fastest agent of soil degradation. Natural ecosystems are protected from this effect by ground cover, but when humans try to use the land for their own benefit, the soil is exposed. The natural fauna that protect the soil from the effects of wind and water are removed to make way for crops. Fortunately, there are a number of techniques that humans can use to protect the soil from erosion when land is used for agriculture. Farming with these methods preserves the quality of the soil for a longer time, resulting in more harvests from the same fields.

This activity allows students to see some erosion-protecting techniques in action. They observe how techniques such as terracing, contour farming, and ground cover reduce the amount of soil that is removed by water erosion. They also get to see that those same techniques increase the amount of water the soil can retain, and can compare the results for these good practices to the results for poor practices. This exercise allows them to see firsthand the effects of good field layout to resist erosion, effects that in the real world take much longer to be apparent.

Background Knowledge

Erosion is one of the major contributing factors of poor soil. One definition of erosion is the process of soil and humus particles being picked up and carried away by water or wind. This can happen anytime soil is exposed or bared to the elements. The humus and topsoil are the parts of soil that contain the most nutrients, and when they are washed away it is hard for the soil to replenish them.[6]

Erosion can be classified into two categories; Natural and Accelerated Erosion. Natural Erosion is the action of the wind, water and gravity in wearing away rock to form soil and shape the ground surface. Except for areas near streams and shore lines, natural erosion is a slow progress that often continues unnoticed. Accelerated Erosion is due to human activity. Humans participate in many activities that destroy the natural vegetation or alter the contour of the ground

[6] Wright T., Richards. *Environmental Science 9th Edition.* Pearson Education, Inc. Upper Saddle River, NJ. 2005

without providing some other sort of surface protection. This greatly increases the rate of erosion that would otherwise be unnoticeable. Accelerated erosion can be minimized by the careful planning and application of appropriate control measures. Farming, construction, logging, and mining are the major actions that cause accelerated erosion. These activities upset the balance that nature has developed between rainfall and runoff.

Wind and water erosion are the two major types under natural erosion. Wind erosion occurs mostly in flat, dry areas and moist sandy soils along bodies of water. Wind erosion removes soil and natural vegetation, and causes dryness and deterioration of soil structure. All mucks, sands, and loamy sands can easily be detached and blown away by the wind. Regular loams, silt loams, and clay loams, and clays are not damaged by the wind, except on wide level plains, where there can be a loss of finer soils.

Water Erosion due to raindrops striking bare soil can be a major problem for farmers. With an impact of up to 30 mph, rain washes out seed and splashes soil into the air. If the fields are on a slope, erosion is intensified as the soil is splashed downhill. This aids in deterioration of soil structure. Soil that has been detached by raindrops is more easily carried away by draining water. Three categories of water erosion are sheet, rill and gully erosion.

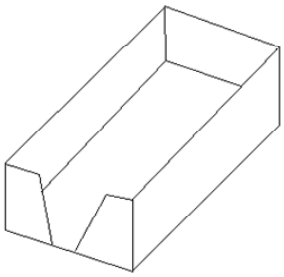
Sheet erosion is defined as the uniform removal of soil in thin layers from sloping land. This is nearly impossible though, as rain tends not to run off in a uniform manner. Rill erosion is the most common form of erosion and the form exaggerated by farming. It occurs when soil is removed by water from little streamlets that run through land with poor surface draining. Rills are often found in between crop rows. Gullies are larger than rills. Gully erosion is a very advanced stage of rill erosion.[7]

There are many types of crop layout that can prevent erosion from ruining the soil around us. This exercise will show how which direction you plant the rows of your crops can make a big difference in the amount of soil carried away by rain. It also demonstrates other good crop layouts.

[7] http://agen521.www.ecn.purdue.edu/AGEN521/epadir/erosion/types_erosion.html. Feb. 24, 2006.

Activity Diagrams for Erosion in Action

Two ways to cut boxes



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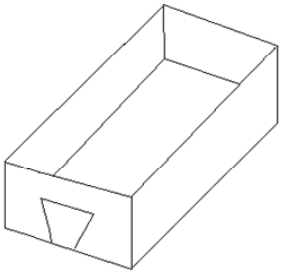
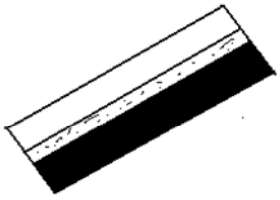
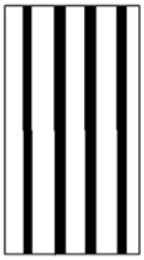
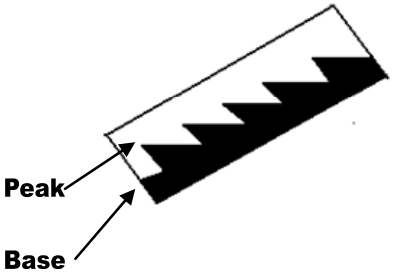




Side View of sod model. Bottom layer is 2 cm of soil with sod, carpet or terry cloth placed on top



Top View of furrow model. Add 3 cm of soil are packed into the box. Four furrows spaced equally apart are made running the length of the box. Furrows should be the width of a finger and 1 cm deep



Side View of terrace model. There should be four to five terraces and the top surface should be flat when the box in inclined. The peak of the terrace should be 3 cm and the base 2 cm.

Title: Erosion in Action[8]

Estimated Time: 1 hour

Materials (per group):

- 3 clear plastic boxes (shoe boxes can be used as alternative)
  - 5 centimeters deep
  - V notch at one end
  - Lined with plastic that extends beyond notch
- 3 Recycled plastic bottles with holes in cap to serve as watering cans
- 3 Measuring cups or graduated cylinders to catch water
- Sod (carpet or terry cloth)
- Soil (obtained from park)
- Water
- Ruler with a centimeter scale

Objective: To develop the students' hands-on appreciation for some of the causes of erosion.

Vocabulary:

- Conservation tillage: the use of equipment during the working of a field that allows for plant residue to stick out of the ground. This agriculture practice reduces wind erosion.
- Reforestation: replanting trees in an area that lost trees as a result of logging or a fire to reduce the effects of erosion.
- Cover cropping: planting a crop, such as winter rye or clover, between periods of regular crops to provide humus or nitrogen and prevent soil erosion.
- Terracing: converting a hillside to a series of descending steps to reduce water erosion. Creating a raised bank of earth with sloping or vertical sides and a flat top.
- Contouring: contouring plowing – the practice of plowing perpendicular to a slope along the contour lines of uneven terrain to limit reduction of topsoil.

Preparations: Make sure boxes are all set and lined with plastic. Measure out 300 mL of water and put into water bottles. Holes in the cap can be poked using a pin or needle.

Pre-Activity Discussion:

- Discuss with students the definition, causes and effects of erosion.
- Ask them if they know of an area prone to erosion.
- Have they noticed anything about the soil there?
- What do they know about it?

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[8] Activity adapted from Science Teacher Resources at http://www.scienceteacher.org/k12resources/lessons/lessonA30.htm Feb. 24, 2006.

- Go over the vocabulary terms with the students and make sure they understand them.

Activity:

1. Split students into 3 groups. Assign each group to a box. NOTE: soil placed in the boxes are packed down, this requires students to gently apply pressure to the soil with the palm of their hand. Soil should not be solid or else no soil will be washed away.
2. Have the first group of students fill their erosion tray with 2 cm of moist soil. Have them place a layer of sod, carpet or terry cloth on top of this and pack it down. The material should be the same size as the box, allowing for most of the soil to be covered.
3. Have the second group of students fill their erosion tray with 3 cm of moist soil and pack down. Instruct this group to make furrows (shallow trenches) parallel to the slope (across the length of the box).
4. Have the third group of students fill their erosion tray with 3 cm of moist soil. Instruct this group to make steps (terraces) across the slope (across the width of the box).
5. Arrange boxes on an incline of 10 cm with the v-notch at the lower end. Place the measuring cups or a drip pan under the v notch of each box. Try to place the cups close enough to try and prevent splashing.
6. Tell all of the students to make some hypotheses. Which tray do they think will lose the most soil to erosion? Which tray do they think will lose the least? Why? Have the students record their hypotheses on their worksheet.
7. Have one member of each group volunteer to sprinkle 300 mL of water on their soil tray. The water should be sprinkled at a height of approximately 30 cm above the tray. One at a time have the volunteers poor all the water onto the upper part of the tray.
8. Have students record the time from the start of sprinkling the water to when the water first starts to come out of the v-notch and until water stops steadily flowing out of the v-notch of the tray.
9. Measure the amount of water that ran out of each box and compare to the amount of water that was sprinkled into the tray.
10. Wait for the water to settle in the cups and look at how much sediment there is. Make comparisons between the trays

Analysis:

Discuss with students their results. Be sure that they answer the following questions:

- Which tray lost the most soil?
- Which tray had the most runoff?
- What does this tell you about each model?
- Which tray showed runoff or erosion first?
- Which tray had runoff the longest?

Conclusions:

- Which agricultural practices would be the most beneficial for controlling erosion?
- Discuss how the different vocabulary practices relate to the experiment and how students can facilitate the implementation of these practices.

Optional Extension: Run the activity with five models. Three of the models are the same as in the basic activity. The fourth box is filled with 3 cm of soil and packed so surface is level. The fifth box is packed with 3 cm of soil and then six equally spaced furrows are made across the width of the box. Furrows should be the width of a finger and 1cm deep.

Soil Scientist Activity

Summary:

This program is intended to teach students about the relationships between soil characteristics, vegetation, and the historical use of the land. Students will act as scientists trying to discover the relationships between humans and the soil. They will travel along a path around the park to visit sites where they will gather information and conduct tests. The sites have been selected to show the different soils in the area as well as how human actions have changed the soil. Instructors at each site will present information about the soil in that area and how the land has been used in the past. At several sites, instructors will be in character. Their roles include a farmer, tin miner, geologist, and park staff. The intention is to provide information in a fun and engaging way that makes students think for themselves.

Preparation: Assign instructors to each site. These instructors should get to the site before the first groups leaves. They should bring a bucket of water with them for soil texture test and hand cleaning. Each group should be given four clear plastic beakers to put soil samples in. The beakers should have a mark to designate one third of the container so students know how much soil to collect. Groups should also be given a couple shovels. Each group should have a group leader and big brother or sister that guides them along the trail.

Soil Scientist Opening talk: at the Soil Scientist HQ

There are a lot of scientists that work here in the park. Who can tell me what a scientist does?

(Should be answers like: experiments, studies, etc., don't need many answers here—just one or two)

Yes, very good. A scientist has to do all these things, *(name some of the answers)*. Who can tell me why?

(The answer you're looking for is: because they want to learn/understand how the world works/why the world is the way it is)

Now, would you believe me that sometimes scientists have to talk to people to find out what they need to know?

Well, they do. Often, looking at experiment results doesn't tell a scientist everything he/she needs to know. Sometimes, he/she has to know about things other people have seen. I want you to remember that.

Today, our group of scientists needs your help. We've heard that the area around here has a lot of variety in its forests. We suspect that the diversity in the forests has to do with the soil. We'd like you to help us figure this out. We want you to look at some of the different types of forest, and find out if the soil is related somehow to those forests. We'd also like you to try to find out why the soil is the way it is in those places. If you have trouble, try listening to people who know what this place used to be like before you came here.

Group Leader Observation guidance for after the introduction:

- Make sure the students know that part of what a scientist does is make hypotheses and check them.
- Let the students know that before they go check the soil around the park, they should go investigate what the soil the park uses in its gardens is like

Park Staff/Gardener: near the park office (Do soil texture activity and collect soil sample for soil texture activity)

Oh, hello. I heard that there was going to be a team of young scientists coming through here today. I'm a gardener for the park, and I've been working on all the beautiful trees and plants you see around you. Do you like the gardens around here?

(I HOPE that they say YES, but it doesn't really matter)

Thank you very much. We have to work really hard here; the natural soil all around us is all sandy and gravelly. There aren't many nutrients in it, and not much organic matter. It's hard to grow much out of the natural soil here.

To help us out, the park brings in soil from elsewhere. You can see some of it right here. We get this from some mountains in another valley—I've heard over there that there's some good, lush forest that hasn't been farmed or mined.

Here, take a look at it. It may help you understand the soil you see elsewhere. I can tell you this: you won't find much better soil for growing things near here.

Group Leader Observation guidance for after the garden site:

- Make sure that students understand that what they see is what healthy soil looks like.

- Make sure students notice the wide variety of plants that grow near the park office
- If students do not notice it themselves, also point out the constant irrigation that goes on at the park

Geologist: at the soil formation site (Optional, this site can be less formal and the group leader can just briefing describe soil formation)

Hello! So you're the new group of scientists who've come to help us out. Good to meet you. I'm a geologist; I study the rocks at the park here. You may be wondering why it's so important to study rocks. Well, I think you know a bit about that already! There are rocks far below the soil we walk on. These are called the parent material of the soil. These get worn down over a long time into the mineral part of the soil. Minerals are the part of the soil that gives it a lot of its color. By studying these rocks, and some of the soil here, I can find out what types of minerals are in the soil. But there's more to the soil than that! Who can tell me what else is in the soil?

(Listen for someone to say something about organic material – there may be something about nutrients, if so, lead them to discuss where those come from)

Yes, organic material is the other big part of the soil. That part comes from the top, where plant leaves and dead animals are decomposed. They get mixed with the little pieces of rock in the ground to form soil. The organic matter makes soil darker, sometimes almost black. It's important when studying the soil to look at what kind of plants grow in the soil and what is covering the soil. Those can give you an idea of why the soil has the color it does.

Group Leader Observation guidance for after the soil formation site:

- Discuss with interested students the condition of the dirt path that the trail turns on. The sandy, gravelly soil that makes up the path is evidence of another type of erosion: erosion from people, animals and machines moving across it.
- Make sure to point out significant changes in the plant life along the path. The brown, dry area just after the soil formation site gives way to planted trees, then scrub, and eventually, bamboo (just before the next site).

Farmer: in the bamboo forest (Do soil texture activity and collect soil sample for soil texture activity) Note: If three people aren't available Person 1 and 2 can be combined.

Person 1: *Can you believe that this area was once used for crops? Even after crops used most of the nutrients in the soil, nature didn't abandon it. I would like you to meet someone who used to farm in this area.*

Farmer: *Tens years ago this land would not have been able to support any plants. Year after year we planted the same crops, mostly soy bean and sugar cane. Once the land was exhausted and stopped yielding crops, we would just leave and find another area to farm. When I left that land I never thought it would be able to recover on its own. This is the first I have seen this land since I left, I can't believe all the trees and plants that are growing! "Do you know why the land has reforested?"*

Person 2: *If abandoned land is left alone, reclamation will happen by itself. First moss will start to grow because it does not need a lot of nutrients and it especially likes the humidity. Next fungi and grass will grow. When they die, they will become fertilizers and serve as nutrients to enrich the soil. Then annual plants will start to grow, followed by perennial plants like all the bamboo trees around here.*

Person 1: *Now this land has the beginning of a bamboo forests, and if you look carefully you can see other perennial plants starting to grow. In 10-20 years it will develop into a full forest again.*

Person 2: *When the land is a full forest the wildlife will come back. "Can you hear any sounds of nature?" (Wait for student responses such as birds)*

Person 1: *The farmers had another occupation, burning charcoal. Do you notice the big pit over there? That was once used to make charcoal. (Some students may know about this from home life)*

Farmer: *Discusses charcoal process…wood places in pit, covered with dirt and then burned for a few days.*

Person 1: *If you look you'll see the pit has no plants. This is because the heat from the fire evaporated all the water out of the soil. And it killed the micro-organisms and earthworms that help to put nutrients into the soil. But even after this process, nature finds a way. Even now you can see moss starting to grow around the edge. The process of reclamation is beginning. I think in a few years that hole will be just like the rest of the area is today.*

Group Leader Observation guidance for after the bamboo forest site:

- Make sure students understand that poor soil is healed through a slow progress, with a progression of plants that grow and heal the soil. They may get some of this from the farmer talk, but make sure that they understand that the poorest soil allows only things like moss and grass to grow, but that these break up the soil, add nutrients to it, and

protect it from erosion. They make the soil good enough for small trees to grow, then bamboo, then large hardwood trees.

- If students are interested, show them the charcoal pit. The soil in the pit is hard, and nothing grows in it. The fire in that pit has baked the soil into a hard layer. If you can see some moss growing on it (there can be some found on the upslope side of the hole), make sure students see that. It shows the beginning of the succession of plants that can heal the soil.
- As you are walking to the next site, again, point out changes in the forest type. One interesting place is where there are irrigation ditches that change the vegetation around them.
- After going down the hill near the mining site, if students do not comment on the soil at the bottom, do so. You don't need to discuss or explain the change, but it will connect with the next talk.

There will be a brief break on the trail in between these two sites. A fun activity should be done at this time.

Miner: in the thick forest, near the old mining culvert (Do soil texture activity and collect soil sample for soil texture activity)

Hello, everyone. I suppose you're the scientists I heard would be coming around here to survey the soil?

Well, I certainly have seen a lot of soil in my life, though I can't say I know all that much about it. See, I was a tin miner here. Most everyone was, at one time.

Tin in this valley is in little pieces, mixed in with the soil and rock. To get it out, we used water—we channeled streams from up in the hills into smaller and smaller pipes. By the time it came out at the bottom, it was a powerful jet of water. We sprayed the ground where we thought there was tin with that water; I remember it could wash away entire hillsides. The water would carry the sand gravel and tin away with it.

We then ran that water through a sluice with grooves on the bottom. The heavy tin would sink down and get caught in the grooves. We kept that tin, and let the remaining sand, soil and gravel wash away in the water.

But all that other sediment had to go somewhere. Most of it was dumped into huge sand piles. The rest flowed down the streams and rivers all throughout the area. I wouldn't be surprised if you can still find evidence of the tin mines in many places around here.

Group Leader Observation guidance for after the mining site:

- Make sure that students notice that even though in the mining trench there are fallen leaves and other ground cover as outside of it that not much grows in the trench.
- The students may be interested to know that the thorny vegetation they see around them is able to store water, so it can grow in dry areas.

Geologist 2: at the waterfall (Optional)

Ah, such a relaxing place, by the waterfall. It's nice here. I really like watching the water run over the rocks, and seeing how it carves the stones into new shapes. Don't you find the shapes of the rocks in the water interesting? It's amazing to think that something so hard and resilient can be worn down by water. It looks like those rocks aren't changing, and it's hard to imagine that they are, but their shapes make it obvious that the water must chip away at them slowly, wearing them down.

If it takes that long for these rocks to wear down, where there's a lot of fast-moving water, how long do you think it takes in places where there's not much water? I've heard it can take thousands of years to make soil from those rocks. Think about how long it takes to make soil that way. Humans can destroy the soil much faster than new soil can be made.

Group Leader Observation guidance for after the mining site:

- Have students guess how long it takes for good soil to form from rocks. They may be surprised that sometimes it can take as much as a thousand years

Lunch will be eaten by the waterfall.

Park Staff 2: at the big tree (Do soil texture activity and collect soil sample for soil texture activity)

Hello! I hope your work has been going well. Have you talked to some interesting people?

(Wait for answers. You may hear about all of them, but the mining one is the important one)

Excellent! Now, I want to know more about the tin mines. You know, the forest has hidden a lot of the really obvious evidence of the tin mining, like the huge piles of sand it left, and the wide open spaces where most plants wouldn't grow. I'm wondering if you found any soil that looked like it was from the tin mines.

(Hopefully yes, try to get a little bit of description about where, what it was like, etc)

Great! I knew there must be evidence out there somewhere. Now, we know that the tin mines had a main camp right near here. Tin mines leave behind poor soil but surprisingly this large tree has been able to grow. It seems to be about 50 years old. Did you know that good soil is often found around big trees? Let's find out if that's true about this tree.

Group Leader Observation guidance for after the mining site:

- Students should realize the benefits such a large tree has on the soil. Discuss with them how the tree helps the soil. A few possible answers are: it protects the good soil from flowing away with erosion, it drops a lot of leaves on the ground that decompose and make the soil richer, it provides food to insects and animals that live in the soil.
- You might want to point out the old cement piling from a mining building that's on the far side of the tree from the camp. You may also want to call their attention to the soil on the hill on the same side-that is an old sediment dumping site from the tin mines.
- As you leave the site, tell students that they will actually get to measure what is in the soil samples they have collected. You may want to briefly tell them about the shake test before you arrive back where they will run that test.

Soil Scientist Activity Instruction

Soil Texture Test[9]

This test will be used to determine the composition of the soil based on feeling the texture of the soil. Students will use a flow chart that will guide them in discovering the composition of the soil at each of the test sites.

Materials (per group):

- 4 (about) 500 mL plastic bottles with pinholes in the top
- 4 Soil texture flow chart

Methods:

1. Have students collect a sample of soil and remove any rocks or large organic pieces.
2. Have students develop a hypothesis about the composition of the soil.
3. Use the water bottle to add drops of water to student's soil samples. Add just enough water to achieve a putty-like consistency.
4. Follow the directions on the Soil Texture Flow Chart to discover the soil composition. Students should record their results on their Data Collection Form.
5. Have students return their soil samples and replace any ground cover. Then have them wash their hands.

Discussion:

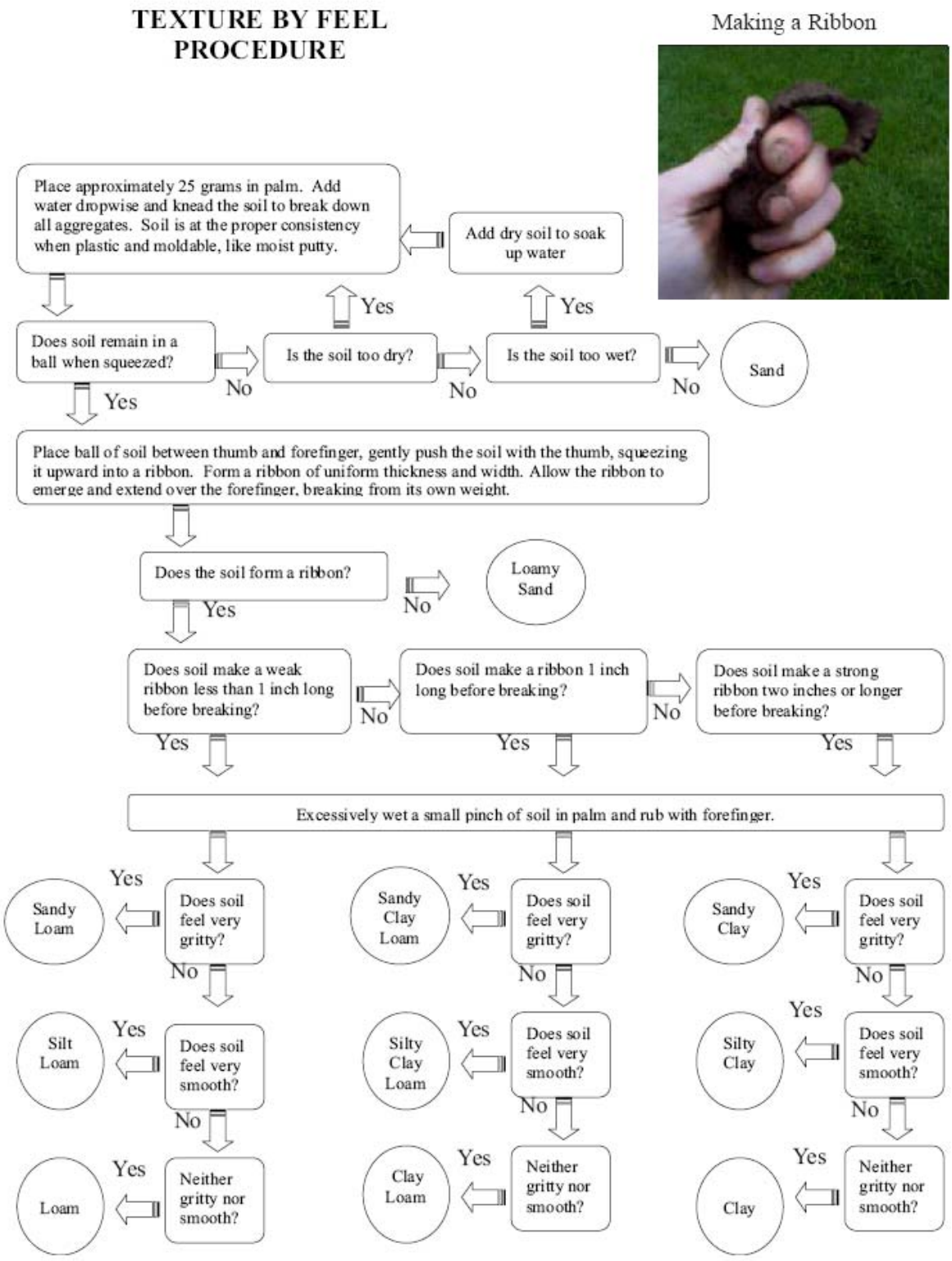
1. How do the results compare to their hypotheses?
2. How does what they found relate to the area's vegetation and history.

Diagram of ribbon:

Ribbon suggested dimensions: width 2 cm and thickness ½ cm.

[9] Activity adapted from USDA at http://soils.usda.gov/sqi/files/KitGuideComplete.pdf

Soil Texture Flow Chart



Soil Shake Test[10]

This test provides students with another look at soil composition. The test allows students to visualize the quantities of each component in the soil sample. Students will collect soil samples at each testing site and conduct the test when they return to the park.

Materials (per group):

- Soil
- 4 clear containers with lids
- Small shovel or butter knife
- Ruler with centimeter scale
- Newspaper

Preparation: Mark on the clear containers 1/3 of the way up the side so students know how much soil to take. Label each container with a site name.

Methods:

At the site

1. Have students get a soil sample without digging any deeper than 5 cm and store it in a test tube. Try not to include plants or rocks. Label the test tube.

At Camp

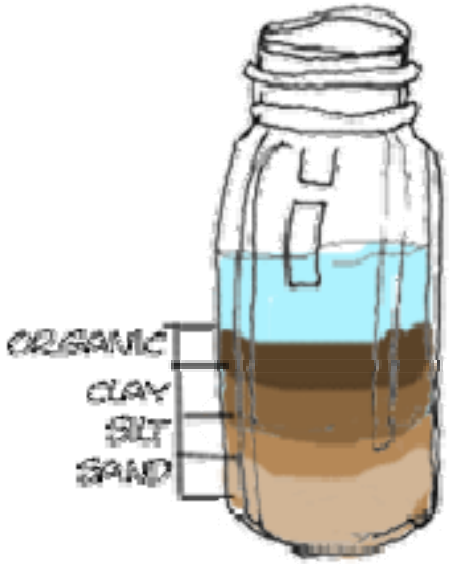
2. Have students develop a hypothesis about the differences between each sample.
3. Place a sample on a sheet of news paper. Instruct the students to remove any large plant material or stones larger than a pea.
4. Have the students pour the soil back into the container.
5. Instruct students to fill their containers 2/3 full of water.
6. Have students cap the container tightly and shake for 30 seconds.
7. Place the container on a solid surface and allow the soil to settle. It should be allowed to sit for at least 1 hour.
8. Place a ruler alongside the test tube once the soil has settled and measure, from the top to the bottom, the thickness of each layer.
9. Have students record the measurements in their data collection sheets.

Discussion:

1. Did the results of this test coincide with the results of the Soil Texture Test.?

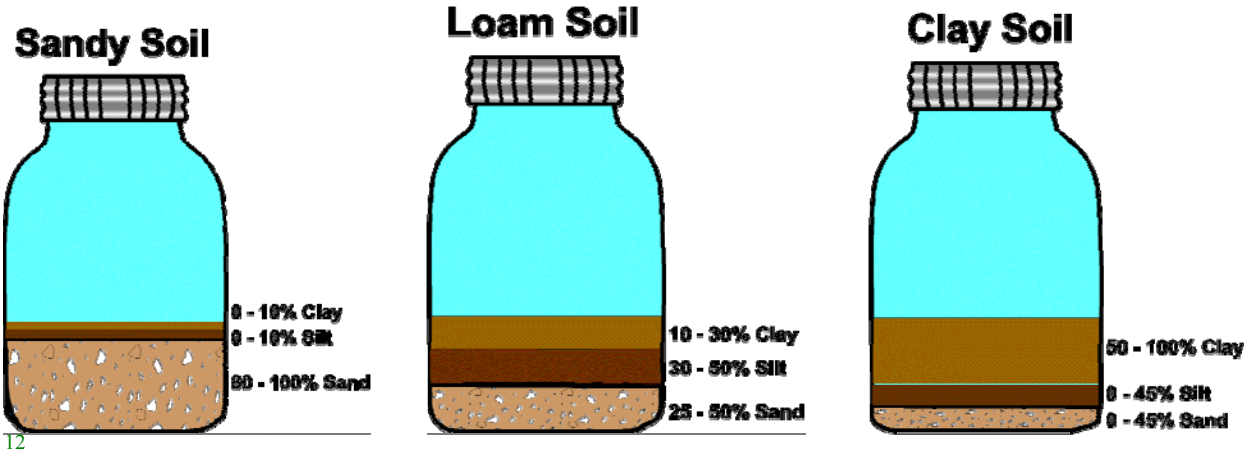
[10] Activity adapted from Underground Adventure at http://www.fieldmuseum.org/undergroundadventure/teachers/mud_shake.shtml

Diagram of Settled Soil:



[11]

Example of Possible Results:



[12]

[11] Picture taken from http://www.suite101.com/article.cfm/shade_gardening/93184/4
[12] Pictures taken from The Global Garden Project at http://www.rain.org/global-garden/soil-types-and-testing.htm

Soil Scientist Schedule

	Group 1 and 2
845	Garden Soil Site
945	Bamboo forest
	Break
1045	Mining Site
1130	Lunch at waterfall
1215	Big Tree Site
1245	Team Building Games
1315	Quick fun activity
1345	First part of soil shake test

	Group 3 and 4
845	Team building games
915	Garden Soil Site
1015	Bamboo forest
	Break
1115	Mining Site
1200	Lunch at waterfall
1245	Big Tree Site
1315	Quick fun activity
1345	First part of soil shake test

Sustainable Agriculture – Instructors Knowledge

Many problems with soil can be fixed by practicing good agricultural practices. This activity will help students to think about ways to improve the nutrients in soil and prevent erosion. Agriculture is the process of redirecting nature's natural food web in order to provide for humans. This isn't a horrible thing, humans need to feed themselves but the way people go about farming can have detrimental consequences for the environment.

The most commonly practiced form of agriculture is called Conventional Agriculture and it involves altering the land by removing trees, tilling the land, using fertilizers and pesticides, and nonrenewable crop plots after harvest. Some effects of this are loss of habitat, soil erosion and water pollution. In the long run, the farmer has to work harder and take over more land when his plots are ruined by lack of nutrients.

One term is becoming very common in the environmental world and that is Sustainable Agriculture. This is the other type of agriculture sometimes referred to as Agroecology which uses ecological principles to farm. This form of farming involves working around the natural land, planting a diverse crop, and using plants as natural insecticides. Planting a diverse crop helps to prevent erosion because the harvest times will be different so the plot will never be bare. A major part of sustainable agriculture is the way crops of planted. The following is a list of good planting techniques which will help protect to soil for years to come. This will not only better the environment but will be beneficial to the farmer as well.

- Strip cropping: crops planted in long narrow fields perpendicular to the prevailing winds. This practice helps to reduce wind erosion.
- Conservation tillage: the use of equipment during the working of a field that allows for plant residue to stick out of the ground. This agriculture practice reduces wind erosion.
- Reforestation: replanting trees in an area that lost trees as a result of logging or a fire to reduce the effects of erosion.
- Cover cropping: planting a crop, such as winter rye or clover, between periods of regular crops to provide humus or nitrogen and prevent soil erosion.
- Inter-seeding: planting different crops together in the same soil.

- Terracing: converting a hillside to a series of descending terraces to reduce water erosion. Creating a raised bank of earth with sloping or vertical sides and a flat top.
- Contouring: contouring plowing – the practice of plowing along the contour lines of uneven terrain to limit reduction of topsoil

Sustainable Agriculture – Teaching Manual[13]

Time: 1 hour

Materials:

- Poster board
- Color markers, pencils, crayons, paints
- Newspapers
- Magazines

Background:

1. Introduce the term Sustainable Agriculture:
    - A philosophy that promotes the integration between plant an animal production using practices with site-specific to:
        - satisfying human food and fiber needs
        - enhancing environmental quality
        - maintaining the natural resource base
        - making efficient use of renewable and nonrenewable resources
        - integration of natural biological cycles and controls
        - ensuring the short- and long-term profit and strength of farms
        - enhancing the quality of life for farmers
        - promoting strong rural communities
        - Example practices:
    -
2. Introduce the term Agroecology:
    - A philosophy involving more environmentally and socially sensitive approach to agriculture; one that focuses not only on production, but also on the ecological sustainability of the production system.

Activity:

1. Have students create a poster or collage that illustrates methods farmers can use to protect the environment through sustainable agriculture practices. There are no guidelines, students are encouraged to work together and be creative in designing their visual.

Ask each group to present their collage to the rest of the students.

[13] Activity adapted from University of Illinois Extensions at http://www.urbanext.uiuc.edu/ecosystems/teacherguide5.html Feb 24, 2006

Review Lecture

(Based on 9 Pre/Post Test Questions presented by grouping
Similar questions together so that they are easy to follow and logical)

Set-up: It is suggested that visuals are made with answers written in diagram form. Answers are covered and when mentioned by students are then uncovered. In this way, it is like a game for students. The material should be reviewed in a fun, stress free environment.

1. Can anyone tell me the components of soil?

- Sandy soil
- Silt — *main components*
- Clay
- Organic matters — *nutrients*
- Minerals
- Water/moisture
- Air

(8) Can you tell me the sources of soil nutrients? Hint, what did you see at the big tree yesterday?

- Animal litters, animal remains
- Leaves, plant remains
- Minerals from dissolved rocks

2. What are the characteristics of good soil?

- Loam (sand + silt + clay)
- High in nutrients (organics + minerals)
- Have suitable filtration and adsorption ability.

3. How can we tell the different between **good soil** and **bad soil**? Hint what kind of test you can use?

The following are signs of good soil:

- It is loam (sand + silt + clay)
- It contains lots of nutrients and we should see pieces of plants, leaves, roots mix together. We should see colony of small animals such as ants, termites, other insects, earth worms in the soil.
- The soil has dark color, moist, and loose.

4. Soil erosion can happen by itself (a natural thing) however, human activities can accelerate erosion. Can you tell me examples of human activities that speed up soil erosion?

- Mining
- Deforestation, forest fire
- Single crop cultivation
- Slash-and-burn practice
- Construction, city enlargement
- Coal pit (harden soil, kills soil animals and microbes, creates toxic substances, etc.)

5. From the question above (4), can you suggest alternatives to the unsuitable activities that are friendly to soil?

- Practice responsible mining methods
- Forest conservation, protect forest fire
- Practice crop rotation, plow and till farmland
- Do not practice slash-and-burn
- Have good urban planning and build only necessary
- Protect top soil
- Use terrace farming or setting plant rows diagonal to the wind and water flow direction

6. Agriculture is very, very important to the people here and you already learnt that poor agricultural practices are not good for the soil and the environment. Can you give me examples of poor agricultural practices?

- Single crop cultivation
- Slash-and burn practice
- Use of chemical fertilizers, pesticides, herbicides.
- Align planting rows in parallel to the wind and water flow direction

- Leave top soil uncovered.

7. For the past 3 days, you have made acquaintance to Uncle Suthep and his crew who works at this beautiful Nature Education Park. What do you think their work has to do with protection of the forest and the environment in this area?

- Protect the habitats to wildlife.
- Protect the forest and allow the trees to mature protecting more soil as the consequence.
- When the forest gets denser, the forest will help collect moisture and we will get more rain in the area and plenty of water in the streams and waterfalls.
- The soil in this old mining area will becomes fertile and suitable for agriculture.
- The people living in the area will enjoy the rich natural resources.
- The park may become a popular tourist destination (ecotourism is best) and a good diverse site for nature education.

(9) The diagram of "Soil/Nutrient Cycle" is presented in this question to remind the students that the forest is very important and is the habitats for herbivores, carnivores, human, decomposers, etc. The Park contains all of these and Khun Suthep and his crew are working very hard to protect the community assets but not for their own benefits.

Just Passing Through – Student Worksheet

1. Soil 1 is _____color. Soil 2 is _____color.

2. Soil 1 is (circle one):

   SAND CLAY SILT LOAM

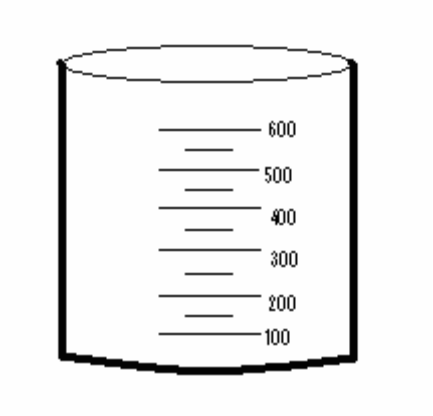
   Soil 2 is (circle one):

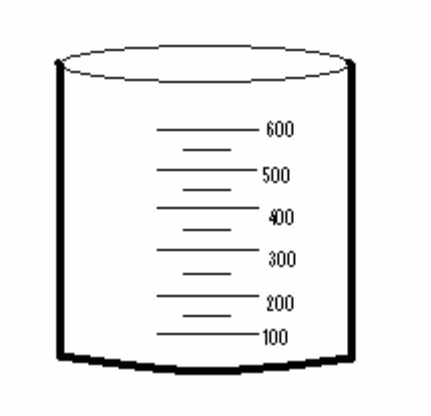
   SAND CLAY SILT LOAM

3. Draw what each soil looks like:

Hypotheses:

4. How much water do you think will come out?

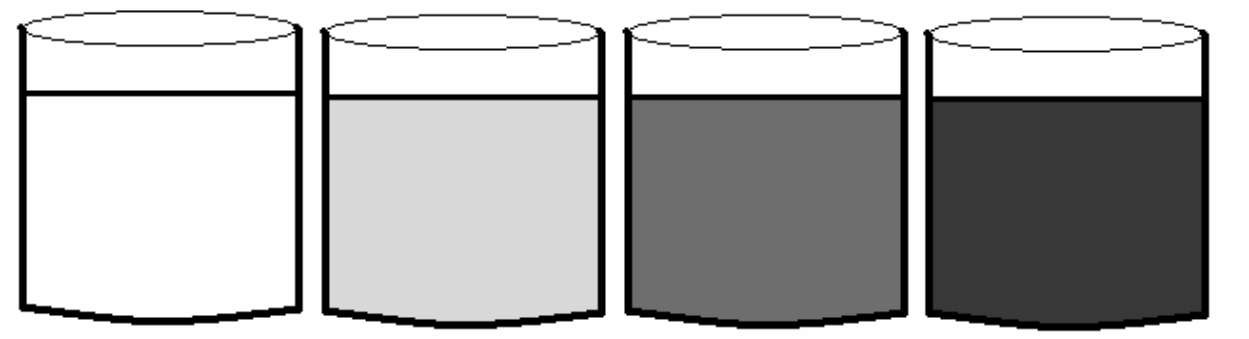




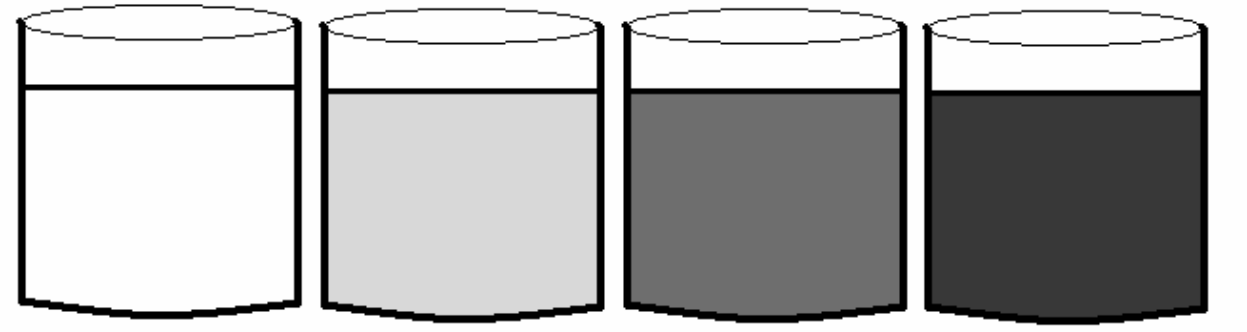
Soil 1 Soil 2

5. What do you think the water will look like? (circle one)

Soil 1:



Soil 2:



Experiment and Report:

For Soil 1:

6. Does the water stay on top? _____

7. Are there any air bubbles on the surface of the water? _____

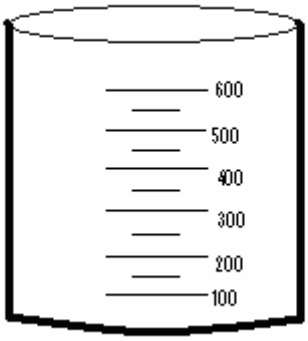
8. Does the soil where the water was poured change? How?

_____

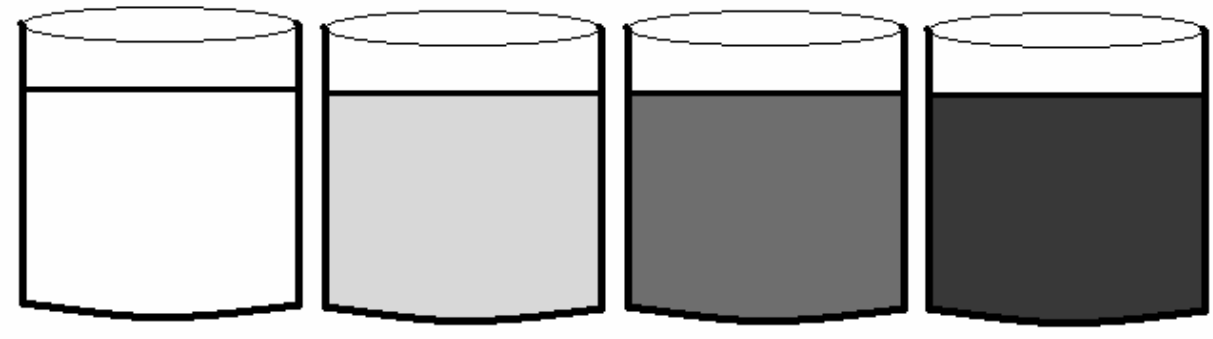
_____

9. How long did it take for the water to come out? _____

10. How much water came out?



11. What did the water that came out look like? (Circle One)



For Soil 2:

12. Does the water stay on top? _____

13. Are there any air bubbles on the surface of the water? _____

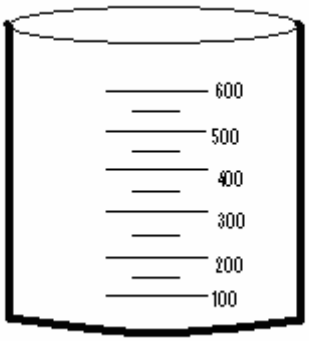
14. Does the soil where the water was poured change? How?

_____

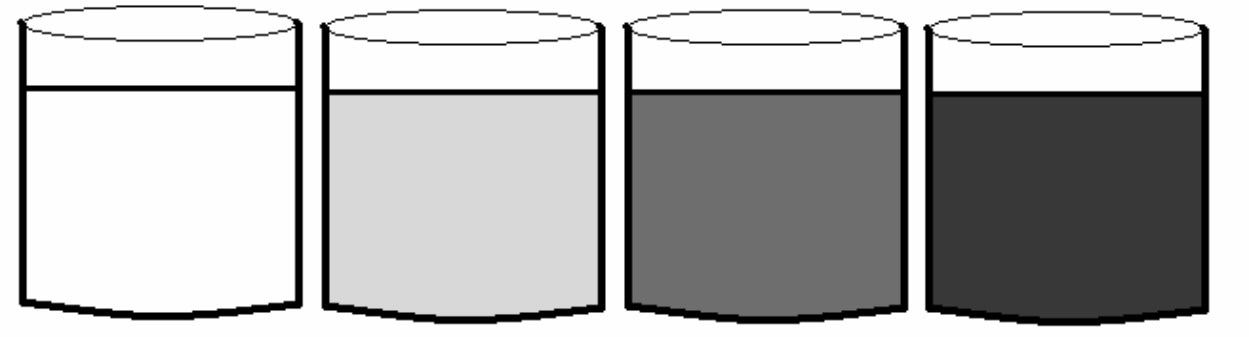
_____

15. How long did it take for the water to come out? _____

16. How much water came out?



17. What did the water that came out look like? (Circle One)



Conclusions:

Answer each question for both soils:

18. Is the amount of water that came out of the soil the same as the amount that you began with? How much water is missing for each?

_____

_____

19. What happened to the missing water?

_____

_____

20. Is the water clearer or a different color than when it went in? Why?

_____

_____

_____

_____

My Report

_____

_____

OPTIONAL EXTENSION OF ACTIVITY

21. What do you think would happen if you added another 600 mL of water to the soil that is already saturated?

_____

_____

22. Will the water filter through slower, faster, or at the same speed as the last time?

_____

_____

23. Will the filtered water be cleaner, dirtier, or the same as last time? Why?

_____

_____

24. Repeat the experiment with another 300 mL of water.

    a. Did the water flow faster or slower?

    _____

    _____

    b. Why do you think the water flowed slower or faster?

    _____

    _____

    c. Did more or less water flow out? And why?

    _____

    _____

d. Is the water clearer or dirtier than the first time? Why?

_____

_____

Erosion in Action – Student Worksheet

Hypothesis:

Which tray do you think will lose the most soil to erosion?

_____

Why?

_____

Which tray do you think will lose the least soil to erosion?

_____

Why?

_____

Results:

Volume of water poured into each erosion tray was _____ ml.

	Tray 1: Sod	**Tray 2:** Furrows	**Tray 3:** terraces
Treatment			
Time for water to start running out of v-notch			
Total time water runs out of tray			
Volume of water that "ran off" of tray			

1. Which tray lost the most soil? _____

2. Which tray had the most runoff? _____

3. Which tray had runoff first? _____

4. Which tray had runoff the longest? _____

Conclusion:

1. If you were planting a farm on a hillside, what would you do to protect your field from erosion?

_____

_____

_____

2. Why do you think it is important to protect a field like this?

_____

_____

_____

OPTIONAL EXTENSION OF ACTIVITY

Activity with five models

	Tray 1: none	**Tray 2:** sod	**Tray 3:** contour	**Tray 4:** long trenches	**Tray 5:** terraces
Treatment					
Time for water to start running out of v-notch					
Total time water runs out of tray					
Volume of water that "ran off" of tray					

1. Which tray lost the most soil? _____
2. Which tray had the most runoff? _____
3. Which tray had runoff first? _____
4. Which tray had runoff the longest? _____

Soil Scientist: Data Collection Form

Field Site number: _____

Date: _____

Time: _____

General Observations

Choose a spot at the field site to sit down and record the following observations. Describe the similarities and differences between things you have observed.

1. What types of plants are growing in your area?

_____

_____

_____

2. What is the ground cover made up of?

_____

_____

_____

Clear the ground cover from a small area so you can examine the soil

3. How does the soil feel (circle all that apply)? Hard Clumpy Soft Fluffy
4. Rub some soil between your fingers. How does it feel? □Rocky □Gritty □Smooth
5. What is the color of the soil? _____

Soil Texture Test

Hypothesis: What type of soil do you think your sample will be? Why?

_____

_____

_____

Methods: Follow the methods described in the Soil Texture Test

Results: What type of soil is your sample? _____

Discussion: Was your hypothesis correct? Why or why not?

_____

_____

_____

What are some reasons for this type of soil to be located at this site?

_____

_____

_____

Soil Shake Test

Hypothesis: How do you think the composition of the soil at this site will compare to others you have looked at?

_____

_____

_____

Methods: Collect a soil sample from this site. Later, you will follow the methods for the Soil Shake Test to complete this activity.

Results: Draw and label the soil layers that formed during the test in the space provided.

Discussion: Was your hypothesis correct? Why or why not?

_____

_____

_____

Does this test support the results you found in the other tests? How?

_____

_____

_____

Student Pre/Post Test

Fill in the blank with the correct word:

1. When soil is mixed in water, _____ will settle first, followed by _____ and then _____.
2. Plants absorb through their roots _____, _____ and _____ from the soil.
3. _____ live in the soil and help to add nutrients into the soil. Decomposing _____ also add nutrients into the soil.
4. The four things needed for plants to grow are _____, _____, _____, and _____.

Multiple Choice:

5. What are three characteristics of good soil? (Choose one)

   A. Has earthworms, water and air B. Has rocks, moss, and is solid

   C. Is dry, uncovered and has insects

6. Which type of soil filters water the best?

   A. Sandy B. Loamy

7. Which are two ways humans help to cause erosion? (Choose one)

   A. Planting trees and terracing B. Clearing land and mining

   C. Furrow cropping and rotating crops

8. Circle all the ways humans can help to prevent erosion:
   a. Slash and burning
   b. Terracing
   c. Contour Cropping
   d. Clear Cutting
   e. Mowing fields
   f. Cover Cropping
   g. Allowing animals to graze
   h. Reforesting the land

9. Describe how the Park restores the forest.

_____

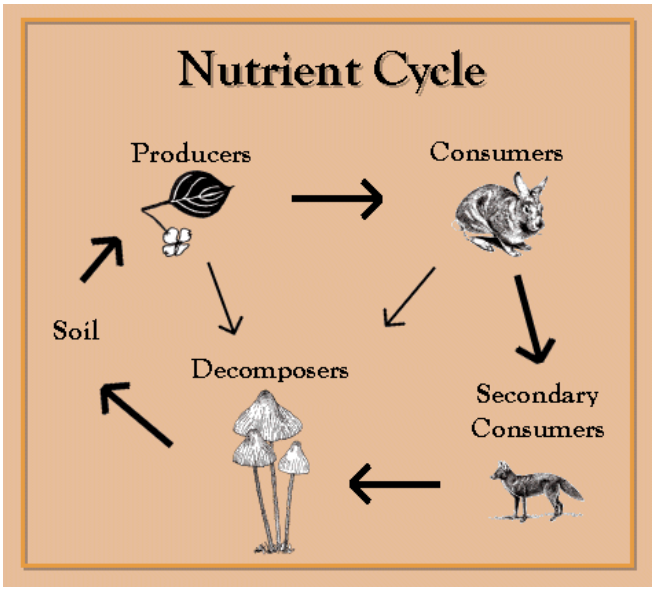
_____

_____

10. Please describe or draw the nutrient cycle.

Answer Key for Pre/Post test

1. In order: *sand, silt, clay* (3 points)
2. All three of: *water, air, nutrients* in any order (3 points)
3. First blank—possible answers include: *Earthworms, microorganisms, decomposers*. Second blank—possible answers include: *dead animals/plants, animal dung.*
4. All four of: *sun, soil, air, water* in any order. (4 points)
5. A (2 points)
6. B (2 points)
7. B (2 points)
8. b,c,f,h are all correct. (4 points)
9. s
10. Should look something like: (1 point for connecting everything to the "decomposers", 1 point for the outer cycle, 1 point for all 5 of the words on the outside)



"Producers" could also be called "plants", "consumers" could say something like "herbivores", "secondary consumers" could be called "predators".